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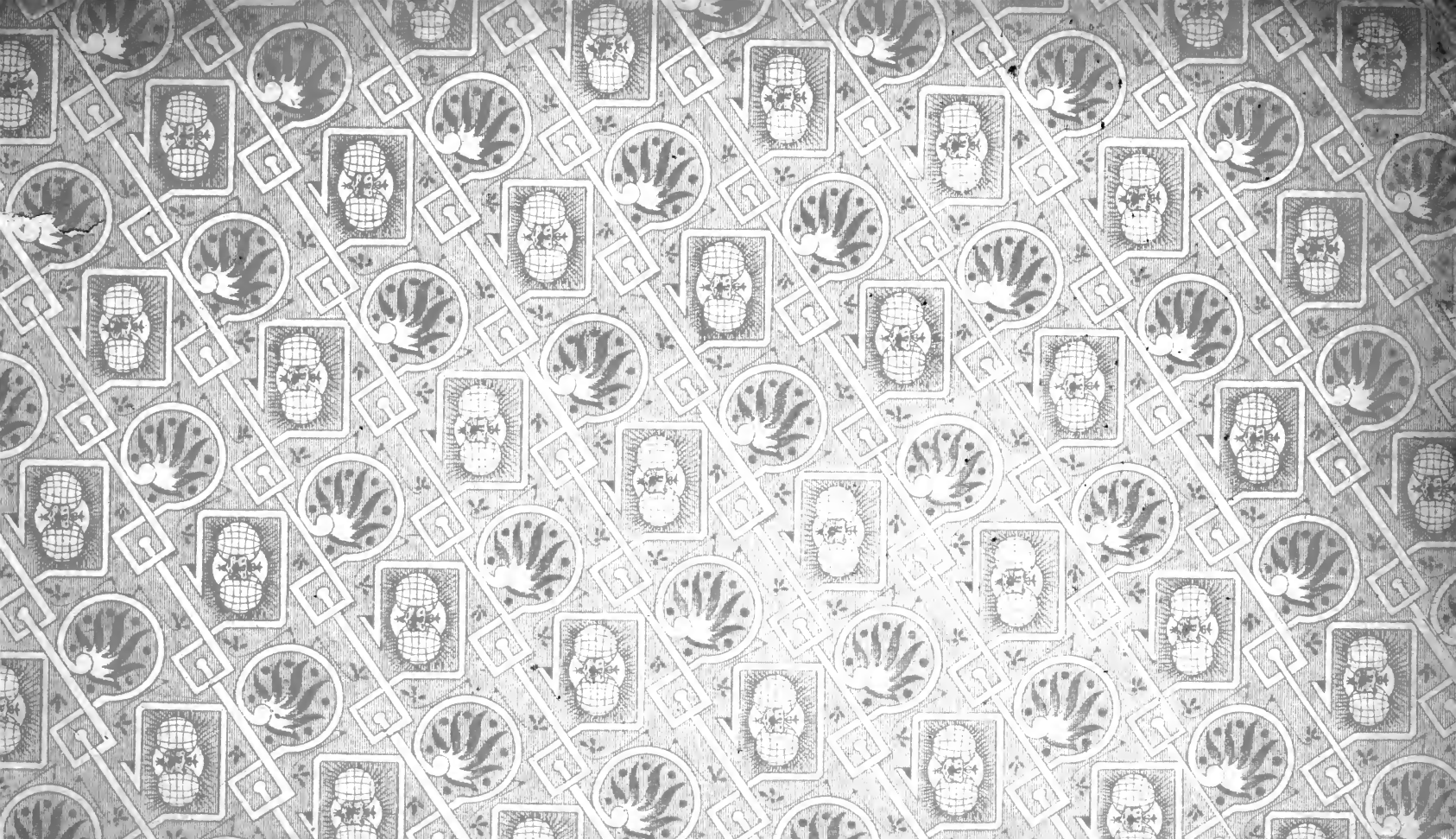

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TEXT-BOOK OF HYGIENE

A COMPREHENSIVE TREATISE

ON THE

Principles and Practice of Preventive Medicine

FROM AN AMERICAN STAND-POINT.

BY

GEORGE H. ROHÉ M.D.,

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SECOND EDITION

THOROUGHLY REVISED AND LARGELY REWRITTEN, WITH MANY ILLUSTRATIONS AND VALUABLE TABLES.

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TO

HENRY INGERSOLL BOWDITCH, A.M., M.D.,

THE PIONEER

IN THE FIELD OF

PREVENTIVE MEDICINE

IN

AMERICA.

PREFACE TO THE FIRST EDITION.

THE aim of the author in writing this book has been to place in the hands of the American student, practitioner, and sanitary officer, a trustworthy guide to the principles and practice of preventive medicine.

He has endeavored to gather within its covers the essential facts upon which the art of preserving health is based, and to present these to the reader in clear and easily understood language.

The author cannot flatter himself that much in the volume is new. He hopes nothing in it is untrue.

PREFACE TO THE SECOND EDITION.

In the present edition the author has endeavored to incorporate the advances made in sanitary science and art since the issue of the first edition.

Additions will be found upon nearly every page, and some of the chapters have been almost entirely rewritten. The size of the book has been increased about one hundred pages, and illustrations have been introduced wherever thought requisite. The thanks of the author are due to Medical Director Albert L. Gihon, United States Navy, for revising the chapter on Naval Hygiene, and to Surgeon Walter Wyman, United States Marine-Hospital Service, for supplying the chapter on Quarantine.

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TEXT-BOOK OF HYGIENE.

CHAPTER I.

AIR.

EXACT investigation into the influence of the atmosphere upon health is yet in its infancy. Enough has been learned, however, to show that changes in the composition of the air, in its density, its temperature, its humidity, its rate and direction of motion, and possibly its electrical or magnetic conditions, influence in various ways the health of the individual. It is only very recently that any scientific attempts have been made to trace the bearing of atmospheric changes upon health. The observations already recorded indicate that a thorough study of meteorological phenomena in connection with the origin and progress of certain diseases is a promising field of labor for the educated sanitarian. The meteorological observations which have been gathered by the United States Signal Service during the past eighteen years, together with the elaborate studies made by the meteorologists and climatologists of other countries, already form such a large and tolerably complete and well-arranged body of facts, that reasonably accurate deductions can even now be made. Heretofore, in studying the sanitary relations of the atmosphere, both in this country and abroad, the attention of observers has been riveted almost exclusively upon the changes in its composition occurring within certain limited areas. It is, perhaps, equally important to study this universally diffused and necessary condition of vital activity in its broader and more general relations. It will be shown, in the course of the present work, that the meteorological features of countries,

or of seasons, or even the daily atmospheric changes, exercise an important influence upon life and health. In order to fully appreciate these relations it will be necessary to first give a brief summary of the facts and laws of meteorology.

THE COMPOSITION AND PHYSICAL CONDITIONS OF THE ATMOSPHERE.

Atmospheric air is a mixture of four-fifths of nitrogen and one-fifth of oxygen; more accurately, 79.00 of the former to 20.96 of the latter. In addition, there is constantly present a modicum of carbon dioxide, usually a little over .03 per cent. (3 to 4 parts in 10,000), traces of ammonia and nitric acid, and a variable proportion of vapor of water.

These proportions are maintained, with but very little change, at different heights. At first thought, it would seem that carbon dioxide, being much heavier than the other constituents of air, would accumulate in the lower regions of the atmosphere, and there cause an excess of this poisonous constituent, but in obedience to the law of diffusion the intermingling of the component gases is perfect, and the proportion of carbon dioxide in the atmosphere is quite as great on mountain-tops as in the deepest valleys.

The proportion of nitrogen in atmospheric air is generally uniform, while that of oxygen varies, depending to a great extent upon the amount of carbon dioxide present. Hence, an increase in the amount of the latter constituent is usually accompanied by a diminution of oxygen, inasmuch as the formation of carbon dioxide can only take place at the expense of oxygen. The reciprocal activities of animal and vegetable life are beautifully illustrated by these relations between the oxygen and carbon dioxide in the air. In the processes of combustion and oxidation, oxygen is withdrawn from the atmosphere, and combines with carbon, forming carbon dioxide. During vegetable growth, on the other hand, carbon dioxide is withdrawn from the air by the leaves of plants, and decomposed into its elements, carbon and oxygen. The carbon is used in building up the

plant, while the liberated oxygen is restored to the atmosphere. The animal consumes oxygen, and gives out carbon dioxide; the plant resolves this compound into its constituent elements, and gives back the oxygen to the air again.

Some recent experiments of Jolly have shown that on days of northerly winds the proportion of oxygen is higher than the average, while under the influence of the south wind the proportion of oxygen is deficient. The extremes in a series of 21 observations were 21.01 and 20.53 per cent. The difference, .48 per cent., is too small to have any appreciable influence upon health.

The atmosphere extends upward from the surface of the earth to an indefinite distance. The limit has been variously placed at from 75 kilometres to 40,000 kilometres. For all sanitary purposes the former may be taken as the upward limit of the atmosphere. In obedience to the law of gravity, this mass of air everywhere presses directly downward—toward the earth's centre—with a force equal to its weight. If a column of this air be balanced by a column or mass of any other matter—the columns being of the same diameter—we have a relative measure of the weight of the atmosphere. The instrument with which the weight or downward pressure of the air is measured is called a barometer. The atmosphere, at the sea-level, presses downward with a force equal to the pressure of a column of mercury 760 millimetres high. Hence, the barometric pressure at sea-level is said to be 760 millimetres, or 30 inches. If the barometer be carried to the summit of a mountain 1000 metres above the level of the sea, or taken to the same altitude in a balloon, the mercury in the barometer-tube will fall about 90 millimetres. These 90 millimetres of the mercurial column represent the weight of 1000 metres of air now below the barometer, and consequently not measured or balanced by it.[1]

Upon ascending from the sea-level, it is found also that the

[1] The figures here given are not absolute, but merely approximate. The limits of this work do not allow a full discussion of the meteorological elements modifying the pressure of the atmosphere at sea-level.

air, being less pressed upon by that which is still above it, becomes more rarefied and lighter; its tension, as it is termed, is less. Hence, for the second 1000 metres of ascent above the sea, the mercury will fall a less distance in the tube, the weight removed not being so great as in the first 1000 metres.

The following table shows the diminution in atmospheric pressure for every 1000 metres above sea-level:—

TABLE I.

Height.	Barometric Pressure.
Sea-level,	760.0 millimetres.
1,000 metres,	670.4 "
2,000 "	591.5 "
3,000 "	521.0 "
4,000 "	460.3 "
5,000 "	406.0 "
6,000 "	358.2 "
7,000 "	316.0 "
8,000 "	278.8 "
9,000 "	245.9 "
10,000 "	216.9 "
11,000 "	191.1 "
12,000 "	168.8 "
15,000 "	115.9 "
20,000 "	61.9 "

Variations in temperature and humidity of the air influence the tension of the atmosphere in a marked degree, and affect the height of the barometric column. In fact, most of the changes of atmospheric pressure at the surface of the earth are directly due to changes in temperature and humidity. Increase of temperature diminishes the density of the air. Hence, when the temperature rises the pressure decreases.

The proportion of moisture (aqueous vapor), if increased, likewise causes a diminution in pressure. It is found, for example, that when the amount of aqueous vapor in the air increases the barometer falls. This is due to the fact that the specific gravity of aqueous vapor is less than that of dry air, being in the proportion of .623 to 1.000. Hence, as aqueous

vapor is diffused through air, the latter becomes lighter,—or, in other words, the barometric pressure diminishes.

The warmth of the air is primarily derived from the sun. On a clear day about one-fourth of the heat of the sun's rays is given off directly to the air during the passage of the heat-rays to the earth. Of the remaining three-fourths, part is reflected from the earth, while the larger portion is first absorbed by the earth, and then given off by radiation and convection to the superincumbent air.

The air is always warmer near the earth's surface on a clear, sun-shiny day; for, as soon as the earth gets warmer than the air immediately above it, the excess of heat is given off to the latter by convection and radiation. On ascending from the surface of the earth the temperature decreases, and on the summit of a high mountain the air is always colder than at its base.

Professor Tyndall has shown that dry air absorbs less heat than air which is charged with vapor. For this reason the sun's rays strike the earth with much greater intensity on a very dry than on a moist day, while on the latter a larger proportion of the heat-rays is intercepted before they reach the earth.

Recent experiments seem to show, however, that the difference in diathermancy between dry and humid air is not so great as supposed by Tyndall. The depth of the air-stratum, through which the sun's rays pass, is of greater influence than the humidity.

Air, at different temperatures, is capable of absorbing different amounts of aqueous vapor. Thus, air at a temperature of 4° will require a much smaller amount of vapor to produce saturation than air at a temperature of 30°. For this reason air which appears "damp" at the former temperature, both to the bodily sensations and to appropriate instruments, would be considered as "dry" at the latter temperature, although the actual amount of vapor present, or absolute humidity, is the

same in both cases.[1] In meteorological observations for sanitary purposes, the relative humidity is the condition deserving especially careful study.

It must be borne in mind that the mere statement of the percentage of relative humidity, without taking into account the temperature of the air, is of little significance. A like remark is justified with regard to statements of absolute humidity, when used to illustrate the apparent effects of atmospheric moisture upon life and health.

The following table shows the absolute humidity corresponding to the same relative humidity at different temperatures. It also includes the total possible absolute humidity and the difference between the actual and possible humidity (deficiency of saturation) at the temperatures given :—

TABLE II.

Temperature °C.	Relative Humidity (per cent.).	Absolute Humidity (grammes per cubic metre).	Greatest Possible Absolute Humidity.	Deficiency of Saturation.
—20	60	0.638	1.064	0.426
—10	60	1.380	2.300	0.920
0	60	2.924	4.874	1.950
+10	60	5.623	9.372	3.749
20	60	10.298	17.164	6.866
30	60	18.083	30.139	12.056

In forests the relative humidity is usually higher than over unwooded districts, although the absolute humidity may be the same, or, perhaps, even less. The evaporation is usually much greater in the open air than in forests. In closed apartments the evaporation may be greater or less than in the open air, depending upon the local conditions present.

[1] By "absolute humidity" is meant the total amount of vapor present in a certain mass of air. By the term "relative humidity" meteorologists designate the proportion of vapor present at certain temperatures, compared with full saturation of the air with vapor, which is reckoned 100. Thus, air which is saturated, or whose relative humidity is 100 at 4°, would have a relative humidity of only 24, if the temperature were raised to 27°, because in the latter case the capacity of the air for aqueous vapor is increased. Relative humidity is always designated in percentages; absolute humidity in grammes per cubic metre or grains per cubic foot.

The motion of the air—wind—is caused by differenecs in pressure; the latter being due to differences in temperature and humidity. A mass of air traversing a large body of water absorbs vapor, unless already saturated, and becomes moist; if it pass over a wide tract of dry land it loses moisture and becomes dry. Therefore in the eastern portion of the American continent, an easterly or southerly wind, which comes from over large bodies of water, and which is usually warm, and thus capable of holding a large quantity of water in a state of vapor, is always moist. On the other hand, a northerly or westerly wind, coming over a large extent of dry land, and from a colder region, is nearly always a dry wind. On the Pacific coast these conditions are reversed; there a westerly wind is a moist wind, while an easterly wind is dry. The dreaded easterly wind of England is likewise a dry wind. It is probable that the direction and rate of motion of air-currents have considerable influence upon the origin or intensification of certain diseases.

The electrical and magnetic conditions of the atmosphere have been as yet studied to little advantage. It is only known that atmospheric electricity is, in most cases, positive, and that its intensity increases with condensation of vapor. There seems to be no doubt that the varying states of atmospheric electricity are closely connected with evaporation and condensation. There is reason to believe that a fuller knowledge on these topics will yield most important results to the student of hygiene.

Ozone and antozone, or hydrogen peroxide, are usually present in the atmosphere in varying proportions. Careful and extended observations have failed to show any connection between the presence of these agents in the atmosphere and modifications of health. It is probable that the sanitary importance of ozone and of hydrogen peroxide have been much overrated. It is not known that either of these substances has any other function in the atmosphere than that of an oxidizing agent.

The sanitarian should be a practical meteorologist. In addition to a knowledge of the principles of the science, he

should possess the skill to make accurate observations of meteorological conditions, and estimate their significance. But the acquisition of an elaborate collection of instruments, and their regular observation, is too expensive and time-consuming. A German physicist, Lambrecht, has devised an instrument which combines in itself nearly all the requirements of a trustworthy meteorological instrument (Fig. 1). This instrument is called a polymeter, and shows, on easily-readable scales, the temperature, relative humidity, dew-point, absolute humidity in grammes per cubic metre, and vapor tension.

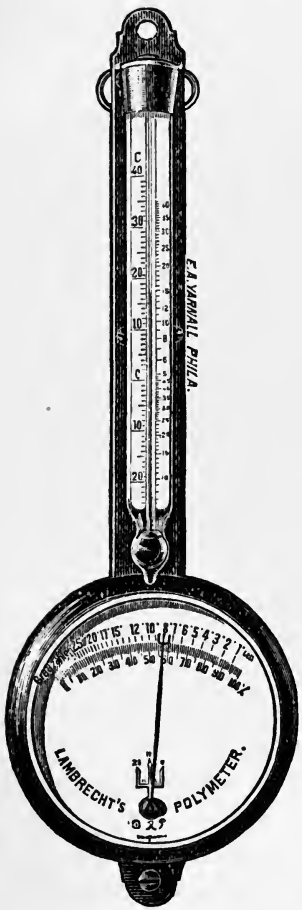


FIG. 1.
LAMBRECHT'S POLYMETER.

INFLUENCE OF CHANGES OF ATMOSPHERIC PRESSURE ON HEALTH.

The effects of a considerable diminution of pressure are familiar to every one in the "mountain sickness" which attacks most persons on ascending high mountains. M. Bert has shown experimentally that similar effects can be produced in an air-tight chamber by diminishing the pressure.[1] The symptoms produced under a pressure equivalent to an altitude of from 4000 metres to 5000 metres were a feeling of heaviness, nausea, ocular fatigue, rapidity of pulse, convulsive trembling on slight exertion, and a sensation of languor and general indifference to the surroundings of the individual.

M. Lortet, who has left on record his experiences in the higher Alps, says that the symptoms noticed on ascending to

[1] Popular Science Monthly, v, p. 379.

high altitudes are: Labored respiration, increased rapidity of pulse, depression of temperature (as much as 4° to 7° C.). The normal temperature was restored, however, after a brief rest.[1] Still more severe symptoms have been noticed on ascending high mountains in South America and Asia. Aëronauts have lost consciousness, and in several instances life, on rapidly ascending to great altitudes.[2] According to the observations of the brothers Schlagintweit, distinguished explorers of the highlands of Asia, the effects of diminished pressure upon the human organism are: "Headache, difficulty of respiration, and affections of the lungs,—the latter even proceeding so far as to occasion blood-spitting,—want of appetite, and even nausea, muscular weakness, and a general depression and lowness of spirits. All these symptoms, however, disappear in a healthy man almost simultaneously with his return to lower regions." A singular observation was made by these travelers on the effect of motion of the air upon the symptoms described. They say: "The effects here mentioned were not sensibly increased by cold, but the wind had a most decided influence for the worse upon the feelings. . . . . When occupied with observations, we took very little, if any, bodily exercise, sometimes for thirty-six hours; it would frequently occur nevertheless, even in heights not reaching 17,000 feet (about 5150 metres), that an afternoon or evening wind would make us all so sick as to take away every inclination for food. No dinner was cooked; the next morning, when the wind had subsided, the appetite was better.

"The effects of diminished pressure are considerably aggravated by fatigue. It is surprising to what degree it is possible for exhaustion to supervene; even the act of speaking is felt to be a labor, and one gets as careless of comfort as of danger. Many a time our people—those who ought to have served us as guides—would throw themselves down upon the snow, declaring

[1] Realencyclopædie d. ges. Heilk., v., p. 529.

[2] MM. Sivel and Crocé-Spinelli, two aëronauts, lost their lives in this manner during an ascent from Paris, in April, 1875.

they would rather die upon the spot than proceed a step farther."[1]

These symptoms disappear when persons are exposed to these conditions for a prolonged time. Thus, in the Andes there are places 4000 metres above sea-level which are permanently inhabited; and in the Himalayas there are villages at a height of over 5000 metres constantly occupied. In this country, Pike's Peak, 4350 metres above the sea, has been occupied since 1873 by observers of the signal service. The men seem to become acclimated, as it were, and suffer little or no inconvenience from the diminished pressure after a time.

The minor disturbances of healthy function produced by diminished pressure (within the limits of 4000 metres altitude, or 460 millimetres barometric pressure) are an increase in the pulse and respiration rate. This is probably due to the struggle of the organism to take up the required quantity of oxygen which is reduced in proportion by the rarefaction of the air. For example, the proportion of oxygen at a pressure of 460 millimetres would be equivalent to 12.6 per cent. at sea-level, instead of the normal 20.9 per cent.

Paul Bert has shown by personal experiments in the pneumatic chamber that the increase in pulse and respiration rate is not due to the merely mechanical diminution of pressure, but to the deficiency of oxygen. Hence the physiological effects of high altitudes upon circulation and respiration are not purely physical, due to diminished pressure, but vital, and depend upon the change in the chemical composition of the atmosphere. The simple diminution of oxygen without reduction of pressure will produce similar though not identical effects upon the organism.

Above the height of 4000 metres above sea-level (below 460 millimetres pressure) the profounder disturbances of function characterized as "mountain sickness" come on. Different

[1] Results of a Scientific Mission to India and High Asia. By Hermann, Adolphe, and Robert De Schlagintweit, vol. ii, pp. 484, 485.

individuals react in different degree to the morbific influences of greatly diminished atmospheric pressure (and coincident reduction of oxygen). Thus Glaisher reached an elevation of 11,000 metres (191.1 millimetres pressure) and returned to the earth alive, while Crocé-Spinelli and Sivel perished at the considerably lower elevation of 8000 metres, equivalent to a pressure of 260 millimetres (7.2 per cent. of oxygen).

The sanitarian is most concerned about the effects of pressure of the atmosphere from 760 millimetres down to 460 millimetres (or up to an altitude of 4000 metres above sea-level). The climatotherapy of various diseases requires that the effects of variations of pressure between these limits should be carefully studied. The observations of Mermod and Jourdanet[1] have illustrated the common physiological effects of these circumscribed changes, while the experiences of therapeutists have established the fact very clearly that many cases of phthisis improve markedly in a rarefied atmosphere. Other observers have also shown that the effects of diminished pressure are not always beneficial, and Dr. Loomis has warned against the sending of patients with heart disease to high altitudes. Whether the lethal effects that have been recorded in such cases are due to the increased activity of the heart and heightened blood-pressure from deficient oxygen, or as suggested by Dr. F. Donaldson, Jr., to dilatation of the heart-walls from diminution of external pressure, is as yet unsettled.[2]

It is probable that the diurnal or accidental[3] oscillations of barometric pressure at sea-level have no appreciable influence upon the organism. The statement is occasionally met that patients subjected to grave surgical operations oftener do badly during low atmospheric pressure, and some surgeons never

[1] Jourdanet states that while the French and Belgian soldiers in Mexico had an accelerated pulse, the natives had a normal pulse. In Mermod's observations the average frequency of the pulse at St. Croix (1106 metres above sea-level) was nearly four beats greater than at Strassburgh (142 metres). The condition of the natives at the high settlements of the Andes and Himalayas has not yet been investigated with exactitude.

[2] American Climatological Association, 1887.

[3] Meaning the oscillation produced by storm waves.

operate when the barometer is low or falling if they can avoid it. An inquiry undertaken by the writer in 1876, in which the excellent records of the Massachusetts General Hospital and the observations of the Boston station of the United States Signal Service for five years were used as the basis of comparison, resulted negatively. The deaths following operations done on days when the barometer was high or rising were exactly equal in number to those following operations when the barometer was low or falling. Unfortunately, the investigation was never pursued to the extent of including other meteorological elements, such as humidity, cloudiness, precipitation, etc. The numerous studies of the relations of variations of pressure to the progress of infectious diseases have also failed to yield any fruits of value. Whether the nerve-pains so frequently complained of, especially by elderly patients, during the progress of areas of low barometer, are due to the diminished pressure, or to the influence of some other meteorological factor, such as humidity or electrical condition, cannot yet be decided.

Increased atmospheric pressure, as noticed in caissons, tunnels, and mines, produces increase in frequency and depth of respiration, diminution in the number of beats and volume of the pulse, pallor of the skin, increase of perspiration (although Smith states that this is only apparent and due to lack of evaporation from the surface), increased appetite, and more abundant excretion from the kidneys.

Among the distinctly pathological effects of increased atmospheric pressure are rupture of the drum of the ear, pain in the frontal and maxillary sinuses, neuralgic pains, nausea, sometimes vomiting and local paralyses. Dr. A. H. Smith[1] defines this collection of symptoms as "The Caisson Disease," and gives the following summary of its characteristic features:—

"A disease depending upon increased atmospheric pressure, but always developed after the pressure is removed. It is char-

[1] The Physiological, Pathological, and Therapeutical Effects of Compressed Air, p. 47. Detroit, 1886.

acterized by extreme pain in one or more of the extremities, and sometimes in the trunk, and which may or may not be associated with epigastric pain and vomiting. In some cases the pain is accompanied by paralysis more or less complete, which may be general or local, but is most frequently confined to the lower half of the body. Cerebral symptoms, such as headache and vertigo, are sometimes present. The above symptoms are connected, at least in the fatal cases, with congestion of the brain and spinal cord, often resulting in serous or sanguineous effusion, and with congestion of most of the abdominal viscera."

INFLUENCE OF CHANGES OF TEMPERATURE ON HEALTH.

Many of the derangements of health ascribed to high temperature are to a considerable degree due to other factors, prominent among which are high humidity, intemperance, overwork, and overcrowding. There can be little doubt, however, that the importance of the high temperature itself can hardly be overrated. It has been generally accepted heretofore that a high temperature, together with a high relative humidity, is most likely to be followed by sun-stroke. A careful comparison in a series of deaths from sun-stroke in the city of Cincinnati in the summer of 1881 shows, however, conclusively that a very high mean temperature with a low relative humidity is more liable to be followed by sun-stroke than the high temperature when accompanied by a high humidity. The same series of observations also shows that the number of deaths was greater on clear days than on cloudy or partly cloudy days.[1] A corroboration of this result is found in the fact that sun-strokes very rarely occur on shipboard, at sea, where the relative humidity is always high.

The direct influence of the sun's rays upon the skin produces at times an erythematous affection which may run into a

[1] The Sun-stroke Epidemic of Cincinnati, O., during the Summer of 1881. A. J. Miles, Public Health, vol. vii, pp. 293-304.

dermatitis if the insolation is prolonged. Artificial heat may produce similar effects.

Diarrhœal diseases, both of adults and children, are much more frequent during hot than cold weather (and in hot than in cold climates), but it is probable that other factors aid in the production of these diseases besides the high temperature.

Certain epidemic diseases are likewise more frequent in, or exclusively confined to, hot climates. These are cholera, yellow fever, and epidemic dysentery. Elephantiasis and the prevalence of certain skin diseases seem also to have some connection with a constantly high external temperature. The intimate relation between cause and effect is not clearly understood, although the belief is current that the origin and spread of such diseases depend upon the development of various parasitic organisms.

Regarding the morbific effects of continued high temperatures, it is probable that an appropriate mode of life, proper diet, and suitable clothing would avert many of the bad consequences. Nevertheless, the fact remains that certain tropical or hot-weather diseases must be considered as primarily dependent upon high temperature, although the pathological effects may be due to an intermediate factor. It is not improbable that micro-organisms will be found to explain yellow fever, cholera infantum, and tropical dysentery. Cholera has already been shown to depend upon a pathogenic organism. In this case the high temperature is one of the associate but none the less indispensable factors in the production of the disease.

Extreme low temperature, as observed in the arctic regions, seems to produce a progressive deterioration of the blood (anæmia), in consequence of which most natives of temperate regions who are compelled to remain in the far north longer than two winters succumb to various hæmic diseases, scurvy being the most prominent. It is not improbable, however, that the dietary furnished is responsible for a large share of the evil effects ascribed to cold. The absence of sunlight for a considerable part of the winter season may also have much to do with

the bad influences for which the low temperature is held responsible.

Among the acute effects of great cold, frost-bite is the most frequent as well as the most serious. Loss of portions of the nose, or ears, or even of entire members are not infrequent results of frost-bite.

In the arctic regions one of the most annoying affections which the traveler has to contend against is snow-blindness, a severe ophthalmia produced by the glare of the snow. Neutral tinted glass goggles should be worn as a preventive.[1]

Dr. Henry B. Baker[2] has placed upon record a large mass of observations which appear to indicate that most of the acute diseases of the respiratory organs are caused by a low temperature in conjunction with a low absolute humidity. Dr. Baker furnishes numerous diagrams, which seem to demonstrate that the curves for influenza, tonsillitis, croup, bronchitis, and pneumonia are in general outlines all practically the same, and that they follow the curve for atmospheric temperature with surprising closeness, rising after the temperature falls and falling after the temperature rises. He claims that this sameness indicates that the controlling cause is one and the same for all of these diseases, and that, directly or indirectly, the atmospheric temperature is that cause. They are diseases of the air-passages, and may be supposed to be influenced or controlled by the atmosphere which passes through them. Although the curves are all similar, yet their differences still further support his view, because the order of succession of the several diseases is such as would be expected if caused in the manner which he supposes. Thus croup and influenza precede in time bronchitis and pneumonia; the curve for bronchitis shows that disease to respond quicker than does pneumonia to the rise and fall of the

[1] See Payer's Narrative of the Austrian Arctic Voyage of 1872-74, pp. 250-3 and 317, for an account of the effects of cold on the organism, and on the best prophylactic measures to be adopted. The Report of the Surgeon-General of the U. S. Navy for 1880 also contains (pp. 350-8) a valuable memorandum by Ex-Surgeon-General Philip S. Wales, on Arctic Hygiene.

[2] Trans. Ninth International Med. Congress, vol. v.

temperature. He suggests that the explanation of the causation of these diseases has not been grasped before because one of the principal facts has not been apprehended, namely, the fact that cold air is always dry air; on the contrary, it has been generally stated that when these diseases occur the air is cold and damp. He explains that while the cold air is damp relatively it is always dry absolutely, and he thinks that its bad effects on the air-passages are mainly through its drying effects, which can best be appreciated by reflecting that each cubic foot of air inhaled at the temperature of zero, F. [— 17.8° C.], can contain only ½ grain of vapor [1.33 grammes per cubic metre], while when exhaled it is nearly saturated at a temperature of about 98° F. [36.5° C.], and therefore contains about 18½ grains of vapor [about 43 grammes per cubic metre], about 18 grains of which have been abstracted from the air-passages. Thus cold air falling upon susceptible surfaces tends to produce an abnormal dryness which may be followed by irritation and suppuration. He claims that coryza is sometimes so caused. Under some conditions the nasal surfaces are not susceptible to drying, the fluids being supplied in increased quantity to meet the increased demand made by the inhalation of cold air. In that case an unusual evaporation of the fluid leaves behind an unusual quantity of non-volatile salts of the blood, such as sodium chloride, and an unusual irritation results; he thinks influenza is the name commonly given to this condition. The effects which the inhalation of cold air has on the bronchial surfaces depend greatly upon how the upper air-passages have responded to the increased demand for fluids; because, if they do not supply the moisture it must be supplied by the bronchial surfaces, in which case bronchitis results. Finally, if the demands for moisture made by cold air are not met until the air-cells are reached pneumonia is produced.

These claims are partly supported and partly opposed by an elaborate paper by Dr. J. W. Moore.[1] According to the

[1] The Seasonal Prevalence of Pneumonic Fever, Trans. Ninth Internat. Congress, vol. v.

statistics furnished by this writer, bronchitis and pneumonia show a remarkable contrast as to seasonal prevalence. The statistics of London and Dublin agree very closely upon this point. Bronchitis falls to a very low ebb in the third or summer quarter of the year (July to September, inclusive), when only 12 per cent. of the deaths annually caused by this disease take place in Dublin and only 11 per cent. in London. In the last or fourth quarter (October to December, inclusive) the percentage of deaths from bronchitis rises to 27 in Dublin and 30 in London. The maximal mortality occurs in the first quarter (January to March, inclusive), when it is 38 per cent. in both London and Dublin. In the second or spring quarter (April to June, inclusive) the bronchitic deaths decline to 23 per cent. in Dublin and 21 per cent. in London.

The mortality from pneumonic fever is differently distributed throughout the year. In the summer quarter more than 14 per cent. of the annual deaths referable to the disease are recorded in Dublin and more than 15 per cent. in London. In the first quarter the figures are—London, 31 per cent.; Dublin, 31 per cent. In the second quarter they are—London, 26 per cent.; Dublin, 30 per cent. In the fourth quarter they are—London, 27 per cent.; Dublin, 24 per cent.

It therefore appears that the prevalence and fatality of pneumonic fever from season to season do not correspond with the seasonal prevalence and fatality of bronchitis. The latter disease increases and kills in direct relation to the setting in of cold weather; it subsides in prevalence and fatality with the advance of spring and the advent of summer. Pneumonic fever, on the other hand, increases less quickly in winter and remains more prevalent in spring than bronchitis; its maximal incidence coincides with the dry, harsh winds and hot sunshine of spring, when the diurnal range of temperature also is extreme.

Dr. Moore believes that acute bronchitis is produced directly by the influence of low temperature, while pneumonia requires an additional cause, which he supposes to be a specific micro-organism.

HUMIDITY OF THE ATMOSPHERE AS CONNECTED WITH CHANGES IN HEALTH.

The propagation of certain acute infectious diseases is believed to be due to a high relative humidity. There can be no longer any doubt that a very humid soil and air, especially if connected with a variable temperature, are almost constant factors in the production of pulmonary phthisis. Recent experience in this country and abroad has shown that the high plateaus and mountains, far inland, where the soil is dry and the relative humidity of the air low, are the best resorts for consumptives.

Of the effects of excessively dry air on health little definite is known. It seems probable, however, that catarrhal affections of the respiratory mucous membrane are more frequent in a dry than in a humid climate.[1]

THE SANITARY RELATIONS OF AIR-CURRENTS.

Primarily, winds or air-currents may be considered as favorable to health. By the agitation of the air ventilation is secured, foul air removed from insanitary places, and diluted by admixture of purer air. But air-currents may also be regarded as either directly or indirectly unfavorably influencing health. Vertical currents rising from the ground may carry morbific germs or viruses and give rise to disease. Horizontal currents or winds proper may also be the direct or indirect cause of derangements of health.

Full credit is given by the public to cold winds and draughts in producing catarrhs and rheumatic pains. The progression of certain infectious diseases, especially malaria, is believed with good reason to stand in a definite relation with the direction of the wind.

Certain local winds are known to have a deleterious effect upon living beings, especially when the latter are in bad health. Among these winds is the *mistral*, a cold, dry, parching north-

[1] See *ante*.

west wind which blows along the Gulf of Lyons. It brings on rheumatism and muscular pains, and is said to excite pleurisy and pneumonia and to act unfavorably upon consumptives.

The *bora* is a cold, dry wind coming down from the Alps and continuing across the Adriatic.

The Texan *northers* are well known in the southwestern part of the United States. They are extremely dry, and are often accompanied by a sudden fall of temperature. Changes of 28° C. (50° F.) within twelve hours are not infrequent in Western and Central Texas. Both man and beast suffer intensely from the cold, parching character of the wind.

The *sirocco* of Northern Africa, Sicily, and Southern Italy has a world-wide notoriety for its depressing effect upon human energy. The *harmattan* is equally noted on the west coast of Africa. It is hot and dry, while in Southern Europe the sirocco is hot and moist.

The *simoon* is a hot, scorching wind of India, and is said to be deadly in its effects upon vegetation and extremely deleterious to men and animals who are encountered by it. In Australia and South Africa hot winds are said to occur which completely destroy vegetable life in their track, and are often unwholesome in their effects upon animal life.

The evil reputation of the Alpine *föhn* is very well known, and neither native nor traveler is anxious to encounter it. It is warm and dry.

With reference to the influence of electrical conditions of the atmosphere upon health, no observations have been made which justify definite conclusions.[1]

Mr. Alexander Buchan and Dr. Arthur Mitchell have analyzed the influence of the weather and season upon the

[1] Dr. S. Weir Mitchell has shown, from the record of the case of Captain Catlin, U. S. A. (American Journal Med. Sci., April, 1877, and N. Y. Med. Jour., August 25 and September 1, 1883), that attacks of neuralgia—in this case, at all events—accompanied the progress of storms across the continent. Also, that the periods of maximum pain occurred with a high but falling barometer and increasing absolute humidity. There seems also to be some relation in this case between the maximum pain and the maximum magnetic force as shown by the declinometer. Dr. Mitchell's papers are among the most valuable positive contributions to hygienic meteorology, and deserve careful study.

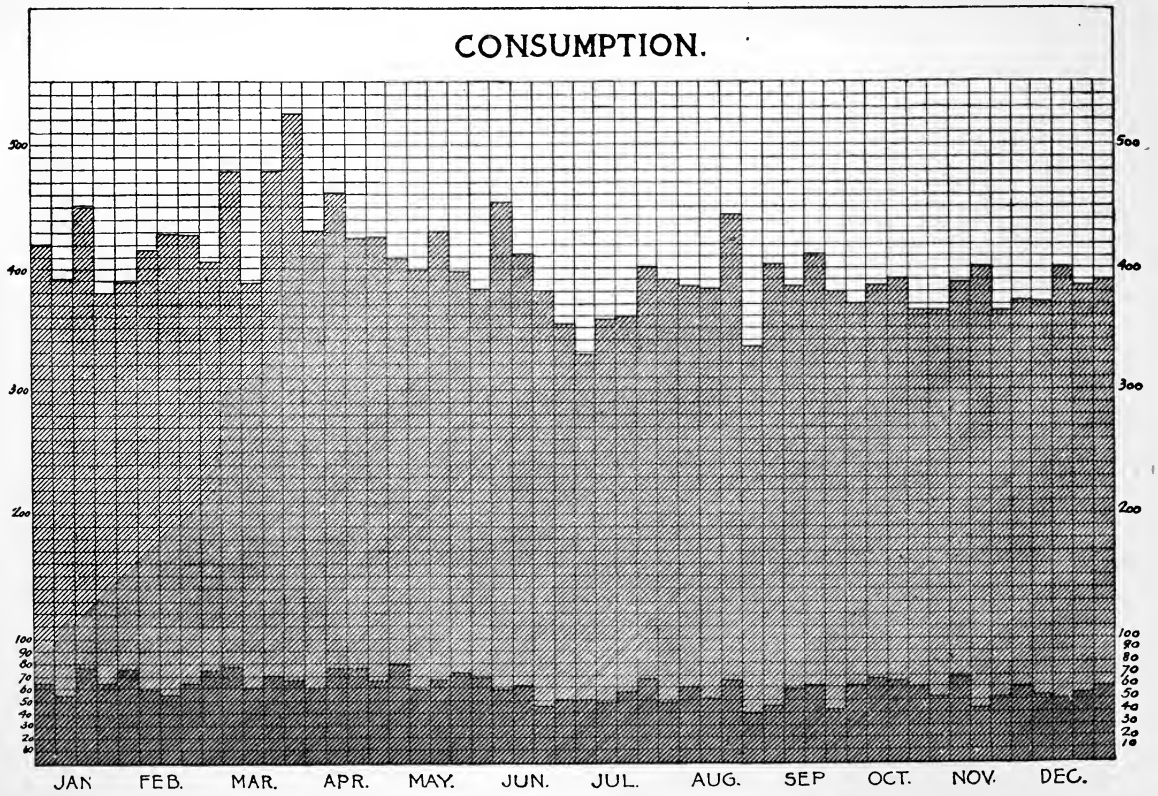
causation of disease, or, rather, upon the mortality from various diseases.[1] Taking the records of the city of New York from 1871 to 1877, it appears that the maximum number of deaths from small-pox occurred in May, the minimum in September. From measles there were two annual maxima and minima, the greater in July and September and the smaller in February and April. From scarlet fever the maximum was in April, the minimum in September. From typhoid fever the maximum was from August to November, the minimum almost equally distributed throughout the rest of the year; from diarrhœa, the maximum in July and August, the minimum from December to March; from diphtheria, the maximum in December, the minimum in August;[2] from whooping-cough, maximum in September and February, minimum in November and June; for croup the curves agree pretty closely with the diphtheria curves; from phthisis, the maximum in March, minimum in June.

The following charts, reproduced by permission of the Massachusetts State Board of Health from the report of that body for 1888, show an almost identical movement of the mortality from different diseases throughout the year. They exhibit the reported mortality for 1888 and also for the six years from 1883 to 1888.

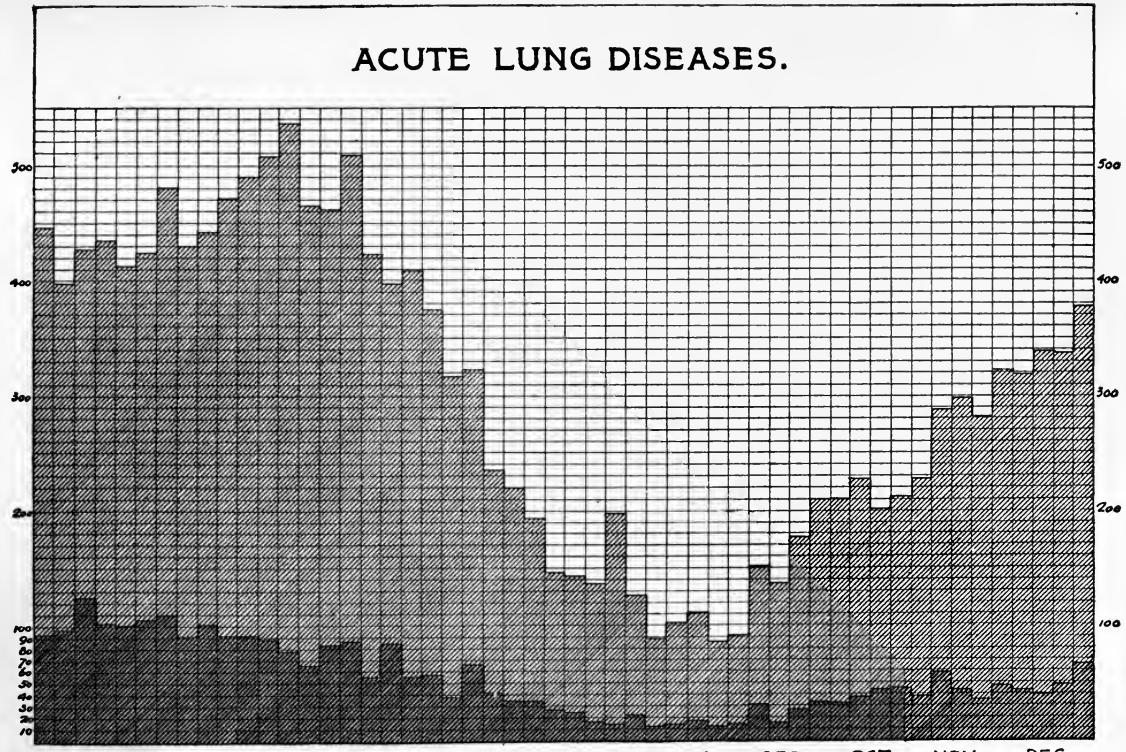
From suicide, curiously, the greater number of deaths occurs in May, the smallest in February. This is contrary to the usual supposition that gloomy weather predisposes to suicide. The six summer months—from April to September—show a much larger number of self-murders than the remaining half-year. In eleven years, ending 1880, there were 1521 cases of self-destruction in New York. Of these 341 occurred during January, February, and March; 417 during April, May, and June; 412 during July, August, and September; and 351 during the last three months of the year. In Philadelphia, the results of examination

[1] Journal Scottish Meteorological Society, 1875-78. (Abstract in Richardson's Preventive Medicine, p. 533 *et seq.* Philadelphia, 1884.)

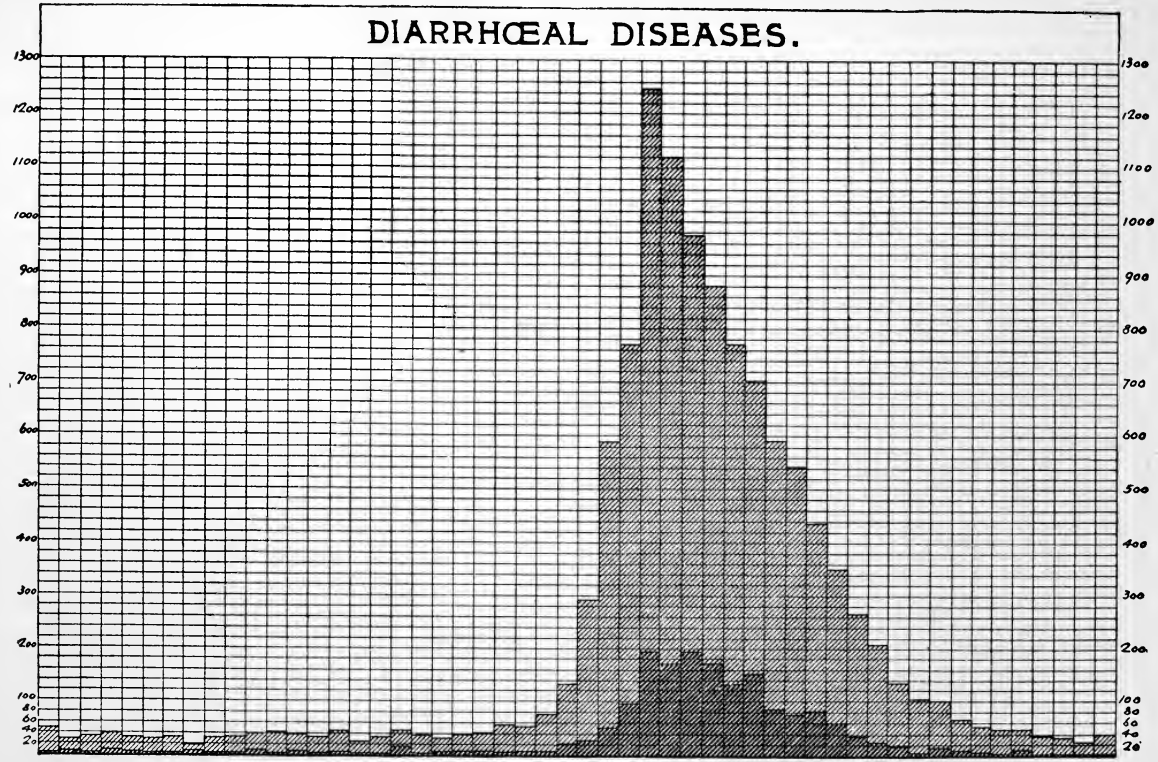
[2] See paper on the Relation of Weather to Mortality from Diphtheria in Baltimore, by Richard Henry Thomas, in Trans. Med. and Chir. Faculty of Maryland, 1883.



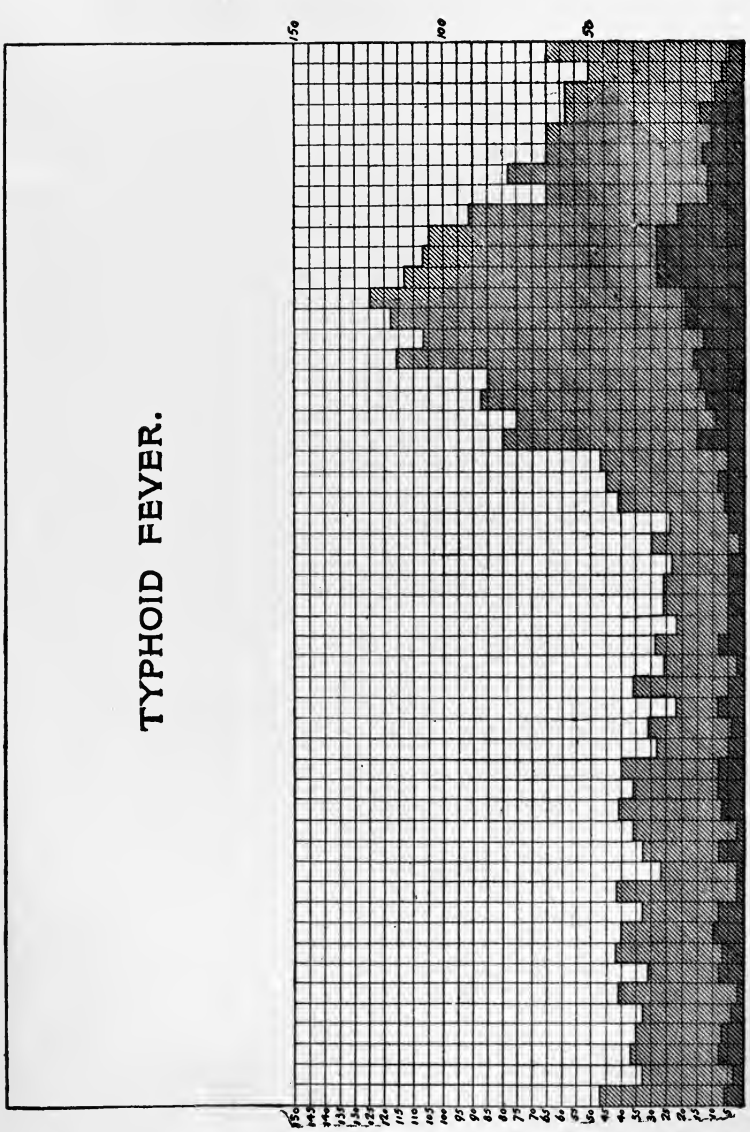
REPORTED MORTALITY FROM CONSUMPTION FOR EACH WEEK FOR 1888, AND FOR THE SIX YEARS (1883–1888).



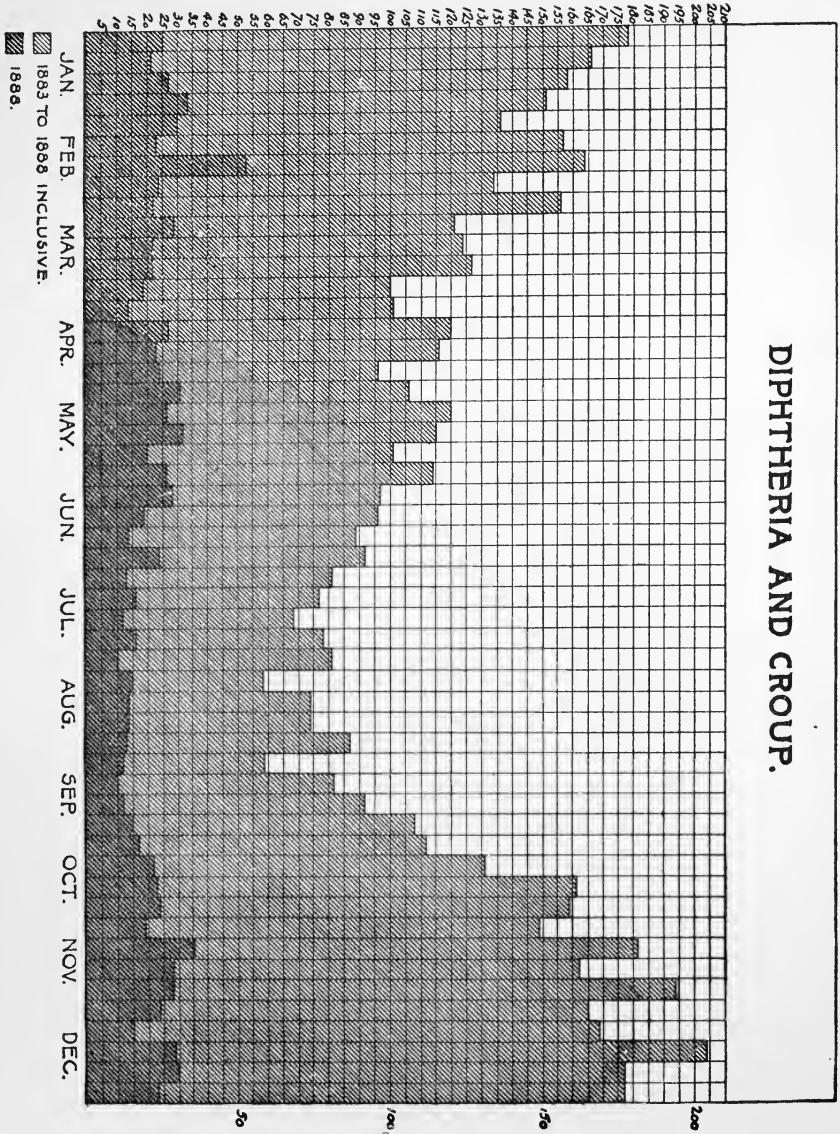
REPORTED MORTALITY FROM ACUTE LUNG DISEASES FOR EACH WEEK, 1888, AND FOR SIX YEARS (1883–1888).



REPORTED MORTALITY FROM DIARRHŒAL DISEASES FOR EACH WEEK, 1888, AND FOR SIX YEARS (1883–1888).



REPORTED MORTALITY FROM TYPHOID FEVER FOR EACH WEEK, 1888, AND FOR SIX YEARS (1883-1888).


DIPHTHERIA AND CROUP.
200
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50
JAN.
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MAR.
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SEP.
OCT.
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DEC.
1883 TO 1888 INCLUSIVE.
1888.

of the statistics of suicide for ten years are almost exactly similar. Out of 636 cases of suicide, 78 occurred in May, 71 in August, 57 in December, 54 each in October, July, and April, 52 in June, 49 in November, 44 each in December and February, 43 in March, and 36 in January.[1] Dr. Lee is led to believe that "a low barometric pressure, accompanied by a high thermometric registry, with sudden fluctuations from a low to a high temperature, together with much moisture and prevailing southwest winds, might somewhat account for the frequency of self-murder in the spring and summer months."

THE SANITARY RELATIONS OF CHANGES IN COMPOSITION AND OF IMPURITIES IN THE AIR.

The average proportion of carbon dioxide in the atmosphere is from 3 to 4 parts in 10,000. Pettenkofer[2] places the maximum limit of carbon dioxide allowable in the air of dwellings at 7 parts in 10,000. It is probable that this limit is very frequently exceeded without serious consequences to health, if the air is not at the same time polluted by organic impurities, the products of respiration. Prof. William Ripley Nichols found the air in a school-room in Boston to contain eight times the normal proportion of carbon dioxide, while Pettenkofer found, also in a school-room, after the same had been occupied two hours, eighteen times the normal proportion, or 72 parts in 10,000.[3] While such an excess of this poisonous gas must unquestionably have an unfavorable influence upon health, it is probable that the most serious effects are due to the coincident diminution of oxygen and the pollution of the air by the products of respiration which necessarily take place during respiration. Carbon dioxide alone may be present in the air to a much greater extent than above mentioned without causing any appreciable inconvenience. In the air of soda-water manufactories

[1] Suicide in the City and County of Philadelphia during a Decade, 1872 to 1881, inclusive, by John G. Lee, Trans. Am. Med. Asso., vol. xxxiii, p. 425.

[2] Quoted in Buck's Hygiene and Public Health, vol. i, p. 615.

[3] See table in Buck's Hygiene and Public Health, vol. i, p. 612.

there is frequently as large a proportion as 2 per cent. of this gas present without producing any ill effects upon those breathing such an atmosphere.

The amount of carbon dioxide in the atmosphere is greatest at night. It is also greater very near the ground than at a distance of several feet above it. As carbon dioxide is absorbed by the leaves of plants during the day-time, but given off at night, the difference may partly be thus accounted for. According to Fodor,[1] the source of a large proportion of the carbon dioxide in the air is the decomposition going on in the soil. This accounts for the larger percentage of carbon dioxide near the ground. This would also explain the variation of the proportion of carbon dioxide in the air under different meteorological conditions. For example, it is found that during rainy weather the carbon dioxide in the air is diminished. This is accounted for partly by the absorption of the carbon dioxide by the saturated ground, while at the same time the porosity of the soil is diminished and the escape of the ground-air prevented.

Mr. R. Angus Smith made a number of experiments upon himself to determine the effects of an atmosphere gradually becoming charged with the products of respiration and perspiration. His experiments were conducted in a leaden chamber holding 5 cubic metres of air. This air was not changed during the experiment. After remaining for an hour in this chamber, an unpleasant odor of organic matter was perceptible on moving about. The air, when agitated, felt soft, owing, doubtless, to the excess of moisture contained in it. The air soon became very foul, and, although not producing any discomfort, the experimenter states that escape from it produced a feeling of extreme pleasure, like "that which one has when walking home on a fine evening after leaving a room which has been crowded."[2]

[1] Hygienische Untersuchungen ueber Luft, Boden und Wasser, Braunschweig. 1882, 2te Abth.

[2] Air and Rain, p. 138.

Hammond [1] confined a mouse in a large jar in which were suspended several large sponges saturated with baryta water, to remove the carbon dioxide as rapidly as formed. Fresh air was supplied as fast as required. The aqueous vapor exhaled was absorbed by calcium chloride. The mouse died in forty-five minutes, evidently from the effect of the organic matter in the air of the jar. The presence of this organic matter was demonstrated by passing the air through a solution of potassium permanganate.

The horrible story of the "black hole" of Calcutta is familiar to every one. Of 146 prisoners confined in a dark cell at night, 23 were found alive in the morning. Among the survivors a fatal form of typhus fever broke out, which carried off nearly all of them. After the battle of Austerlitz 300 prisoners were crowded in a prison; 260 died in a short time from inhaling the poisoned air. Numerous other similar examples of the effects of polluted air are recorded.

Usually the effects of foul air are not so sudden and striking. In most instances, especially where the pollution has not reached a high degree, there simply results a general deficiency of nutrition, which manifests itself in anæmia, loss of vigor of body and mind, and a gradual diminution of resistance to disease.

It seems to be beyond question that persons who are constantly compelled to inhale impure air, especially if combined with an improper position of the body or lack of sufficient or appropriate food, furnish a very large percentage of chronic pulmonary affections. Phthisical patients, in the overwhelming majority of cases, are drawn from the classes whose occupations keep them confined in close rooms. Want of exercise and of good food doubtless aid in the development of the lung disease. Formerly, when less attention was paid to the proper construction and ventilation of barracks and prisons, the mortality from

[1] A Treatise on Hygiene, with Special Reference to the Military Service, by William A. Hammond, M.D., Surgeon-General U. S. Army, p. 170. Philadelphia, 1863.

phthisis among soldiers and criminals was much greater than it is now. In animals kept closely confined the same disease claims a large share in the mortality.

Near the end of the last century over one-third of the infants born in the old Dublin Lying-in Hospital died of epidemic diseases. After the adoption of an improved system of ventilation the mortality fell to about one-tenth of what it had previously been. To illustrate the effect of similar conditions upon the health of domestic animals, the following instance is cited: Upward of thirty years ago a severe epidemic of influenza in horses appeared in Boston. At the instigation of Dr. H. I. Bowditch, every stable in the city was inspected, and classified as "excellent," "imperfect," or "wholly unfit," in respect to warmth, dryness, light, ventilation, and cleanliness. It was found that in the first class fewer horses were attacked and the disease was milder, while in the third class every horse was attacked and the more severe and fatal cases occurred.

Carbon monoxide is a very dangerous impurity often present in the air of living-rooms. Being an ingredient of illuminating gas, as well as the so-called coal-gas, which so frequently escapes from stoves and furnaces, its dangerous character becomes apparent. Many persons die every year in this country from the inhalation of illuminating gas. People unacquainted with the mechanism of the gas-fixtures frequently blow out the light instead of cutting off the supply of gas by turning the stop-cock. It is also a prevailing custom to keep the light burning "low" during the night. Any considerable variation of pressure in the pipes, or sudden draught, may put out the light and permit the gas to escape into the room, with fatal effect. Leaks in pipes or fixtures may have the same results.

Coal-, coke-, or charcoal- fires may produce serious or fatal poisoning if the gas, which contains a large proportion of carbon monoxide, is permitted to escape into the room.[1] In

[1] See paper by Dr. John Graham in Transactions of Philadelphia College of Physicians for 1885.

certain parts of Europe, notably in France, the inhalation of the fumes of a charcoal fire is a favorite method of committing suicide.

The gas which sometimes escapes from the stove when coal is burning has the following composition:—

Carbon dioxide,	6.75 per cent.
Carbon monoxide,	1.34 "
Oxygen,	13.19 "
Nitrogen,	79.72 "

Sulphuretted and carburetted hydrogen are not infrequently present in the air, especially about cess-pools and in mines and certain manufacturing establishments. Sulphuretted hydrogen is generally considered to be a violent poison, but there is no evidence that it is so unless oxygen is excluded.

Carburetted hydrogen is the so-called "fire-damp" of mines, which is so often the cause of fatal explosions. Its inhalation does not seem to be especially noxious. It will be more fully referred to in a succeeding chapter.

Variations in the proportion of ammonia present in the air are frequent. Its presence is an indication of organic decomposition in the vicinity, but nothing is known of the influence of the gas itself upon health, in the proportion in which it is ever found in the atmosphere.

SEWER-AIR.

Sewer-air, or sewer-gas, as it is often improperly called, is a variable mixture of a number of gases, vapors, atmospheric air, and solid particles, and is derived from the decomposition of the animal and vegetable contents of sewers. A number of analyses by different chemists have shown that the composition of sewer-air is extremely variable. The most important components, in addition to the constituents of atmospheric air, are: Carbon dioxide, ammonia, sulphuretted hydrogen, and a number of volatile organic compounds, which give to sewage its peculiar odor, but which are present in such small quantity as to prevent

accurate determination by chemical means. Sewer-air may also contain particulate bodies, bacteria, and other microscopic organisms, which are supposed by many to be the active causes of infectious diseases. Some recent researches by Carnelly and Haldane have shown that sewer-air usually contains a less number of micro-organisms than the external air of cities. The proportion of carbon dioxide found was also much less than was expected. When the contents of sewers remain in these receptacles or conduits long enough to undergo decomposition, sewer-air is always present. It is believed by some physicians and sanitarians that sewer-air is the direct cause of such diseases as typhoid fever, scarlet fever, diphtheria, and cholera, while others hold the view that the sewer-air is merely a favorable breeding-place for the germs of these diseases, and that it thus merely acts as a medium in which the infective agent grows, reproduces itself, and is conveyed from place to place. There is no absolutely trustworthy evidence in favor of either of these doctrines.

It is hardly open to question, however, that the continual breathing of air polluted by emanations from sewers often produces more or less serious derangements of health. Diarrhœa and other intestinal affections, mild cases of continued fever, and even cases of undoubted typhoid fever have been so frequently noted in connection with defective sewerage, and the escape of sewer-air into inhabited rooms, that doubt upon this point is hardly justifiable. With regard to typhoid fever, however, it is probable that the sewage in these cases contained the particular virus (bacillus?) which, it is now generally believed, causes this disease.

The effluvia from cemeteries, knackeries, and other places where the bodies of animals are undergoing decomposition, are popularly regarded as deleterious in their effects upon health. The evidence in favor of this view is, however, very indefinite.

Professor Tyndall has shown[1] that even the apparently

[1] Essays on Floating Matter of the Air. New York, 1882.

clearest air is, when in motion, constantly filled with innumerable particles of dust, which are believed by many to give rise to various forms of disease. The presence of these particles can be easily demonstrated by means of the electric light. Every one has observed these minute particles in a bright ray of sunlight. Under ordinary conditions these particles of dust would, of course, give rise to no trouble, but, if intermingled with these dust-specks there were disease germs,—whether these germs be considered as living organisms, or as particles of dead tissue from the body,—then manifestly the inhalation of such "dust" would be dangerous.[1]

The quantity of dust found in the air of cities is much greater than in the country. Tissandier found that in Paris the percentage of dust was eight to twelve times greater than in the open country. One-fourth to nearly one-half of this atmospheric dust is organic, either animal or vegetable. Very recent observations have shown that in Paris the air contains nine or ten times as many bacteria in a given volume as the air at the observatory of Montsouris, just without the city. The relative proportions of organic and inorganic particles vary as 25 to 75 in Paris, 45 to 55 in Dublin, and 25 to 75 in the open country. The organic particles are either particles of dead organic matter, or minute organisms. The proportion of the latter varies in different seasons, being least in winter and spring, and greatest in summer and autumn. These organisms are not necessarily pathogenetic, but the conditions which favor the proliferation of non-pathogenic bacteria are likely to promote the development of disease-producing ones likewise.

Among the pathogenic micro-organisms found in the atmosphere are spores of achorion Schœnleinii, the so-called malaria bacillus of Klebs and Tommasi-Crudeli, and Fehleisen's erysipelas germ. It is probable, also, that the bacilli of tuberculosis, cholera, and typhoid fever, and other organisms, at times

[1] See Chapter IX, on Industrial Hygiene, for effects of inhalation of dust in various industries.

undergo multiplication in the air, and that the latter may be the medium of communication of these diseases. But it must be admitted that our knowledge upon this point is at present rather vague and unsatisfactory.

As regards the diseases that may be produced by the inhalation of pathogenic organisms there can be no doubt that diphtheria, glanders, measles, scarlet fever, whooping-cough, infectious pneumonia, and, above all, pulmonary tuberculosis, are so caused. It is likewise probable that yellow fever, epidemic influenza, cholera, and typhoid fever may be produced in this manner.

TESTS FOR IMPURITIES IN THE AIR.

The sense of smell will indicate the presence of sulphuretted hydrogen, or of volatile organic matter. Chemical tests and the microscope will, however, be necessary to determine the presence of carbon dioxide, carbon monoxide, or suspended particulate matter in the air.

In order to detect the presence of carbon dioxide, advantage is taken of the affinity of this compound for certain alkalies with which it forms insoluble compounds. If a stream of carbon dioxide gas is passed through lime- or baryta- water, an insoluble carbonate of lime or baryta is instantly formed, and produces a milky precipitate in the water. If, instead of passing a stream of gas through the liquid, the latter be agitated with air containing carbon dioxide, a similar precipitate is produced. The most exact method of determining the amount of carbon dioxide in the air is that known as Pettenkofer's,[1] but it is somewhat complicated. A readier method has been devised by Mr. Angus Smith, and is termed the minimetric test.[2] A series of six wide-mouthed bottles, having a capacity respectively of 450, 350, 300, 250, 200, and 150 cubic centimetres,[3] is fitted with clean, tightly-

[1] Lehrbuch der Hygiene, Nowak, p. 149.

[2] *Op. cit.*, p. 152.

[3] The equivalents in English measures are 14 ounces, 11 ounces, 9⅓ ounces, 8 ounces, 6¼ ounces, and 4¾ ounces.

fitting corks. The bottles are made perfectly clean and dry, and 15 cubic centimetres ($3\frac{3}{4}$ drachms) of clear, fresh lime- or baryta- water put into the smallest, the cork replaced, and the bottle well shaken. If the water becomes turbid there is at least .16 per cent. (16 parts per 10,000) of carbon dioxide in the air treated. If only the water in the largest bottle becomes cloudy, the proportion of carbon dioxide is probably less than 5 parts in 10,000. For the intermediate series of bottles the amounts of carbon dioxide necessary to produce cloudiness are, respectively: For 200 cubic centimetres of air, 12 parts in 10,000; for 250 cubic centimetres, 10 parts; for 300 cubic centimetres, 8 parts; and for 350 cubic centimetres, 7 parts per 10,000. If, therefore, a cloudiness is produced with any of the bottles except the largest, the amount of carbon dioxide present exceeds the standard allowable in pure air. The test should be frequently made, in order to acquire familiarity with its use. The same quantity of the test-liquid is, of course, used in each bottle.

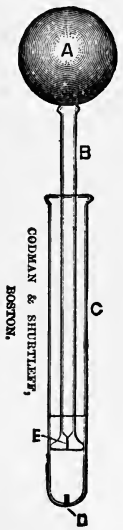

FIG. 2.
AIR-TESTER.

A simple and easily-managed instrument, called an "air-tester," has been devised by Professor Wolpert, a distinguished German meteorologist. It is described as follows by Dr. S. W. Abbott, who first called attention to its merits in this country[1]: The little instrument consists of a simple rubber bulb (A) of a capacity of 28 cubic centimetres, a glass outlet-tube (B) with a constriction near its extremity (E). A glass test-tube, 12 centimetres in length (C) and 2 millimetres in diameter, has a horizontal mark near the bottom, indicating the point to which it must be filled with perfectly clear lime-water, to contain 3 cubic centimetres. The bottom of the tube is whitened and has a black mark stamped upon it (D). A small, wooden stand, a brush or swab, a vial of vinegar for cleaning the tube, and a bottle of clear lime-water complete the outfit.

[1] Boston Med. and Surg. Journal.

In order to use the instrument, the lime-water (saturated solution) should be poured into the test-tube till it reaches the horizontal mark. Press down the bulb with the thumb, so as to expel the air within it as completely as possible, and allow it to fill with the air of the apartment, insert the small tube into the lime-water nearly to the bottom, and again expel the air with moderate rapidity, so that the bubbles may rise nearly to the top of the tube, but do not overflow, taking care to continue the pressure of the thumb till the small tube is removed from the lime-water. Repeat this process until the mark upon the bottom of the test-tube is obscured by the opacity produced by the reaction of the carbonic acid upon the lime-water, the observer looking downward through the lime-water from the top of the test-tube.

With very foul air it is necessary to examine the mark after filling and discharging the bulb a few times only; with good air, it must be filled twenty-five times and upward.

The bulb represented in the cut is made a little larger than the required capacity, since a small amount of residual air usually remains in the bulb and cannot be expelled without great care.

After each observation, the test-tube must be washed out and wiped dry. If a white incrustation forms upon the tube, it may be easily removed with a little vinegar, after which the tube should be thoroughly washed with pure water and dried.

If the mark becomes obscured after filling the bulb ten or fifteen times only, the air of an apartment is unfit for continuous respiration.

In a sick-chamber the air should be so pure that the turbidity of the lime-water will not render the mark invisible until thirty or forty fillings are made.

The instrument should be used by daylight, over a white ground, as a sheet of writing-paper, and care should be taken not to vitiate the result by the observer's own breath.

The following approximate table is taken from the article

by Professor Wolpert, the first column representing the number of fillings of the bulb, and the second column the parts per 10,000 of carbon dioxide in a given sample of air:—

Number of Fillings.	Carbon Dioxide per 10,000.	Number of Fillings.	Carbon Dioxide per 10,000.	Number of Fillings.	Carbon Dioxide per 10,000.
1	200.	21	9.5	41	4.9
2	100.	22	9.1	42	4.8
3	67.	23	8.7	43	4.6
4	50.	24	8.3	44	4.5
5	40.	25	8.	45	4.4
6	33.	26	7.7	46	4.3
7	29.	27	7.4	47	4.2
8	25.	28	7.1	48	4.1
9	22.	29	6.9	49	4.1
10	20.	30	6.6	50	4.
11	18.	31	6.4	51	3.9
12	16.	32	6.3	52	3.9
13	15.	33	6.1	53	3.8
14	14.	34	5.9	54	3.7
15	13.	35	5.7	55	3.7
16	12.5	36	5.5	56	3.6
17	12.	37	5.4	57	3.5
18	11.	38	5.3	58	3.5
19	10.5	39	5.1	59	3.4
20	70.	40	5.	60	3.3

Carbon monoxide is detected by its reaction with palladium chloride, which gives a black color when brought in contact with the gas. If a strip of linen or blotting-paper be moistened with a solution of the palladium chloride (1 to 500) and suspended in air containing carbon monoxide, the black color will be developed. The suspected air may also be passed through a solution of sodio-chloride of palladium, when the liquid will turn black if carbon monoxide be present.

The percentage of organic impurity in the air of an occupied room (products of respiration, etc.) is difficult to ascertain directly.

Pettenkofer has found, however, that the proportion of carbon dioxide present is indirectly a measure of the organic impurity from respiration.[1] As the determination of the carbon

dioxide is easy by the minimetric method of Angus Smith, or the ready method of Wolpert, the extent to which the air is polluted by respiratory impurities is readily ascertained.

The presence of organic and other suspended impurities can be best demonstrated with a microscope. An objective, magnifying upward of 400 linear diameters, and experience in the use of the instrument will be needed to obtain correct results. By moistening a glass slide with glycerin and exposing it in the suspected air, a sufficient quantity of the suspended matters may be collected in the course of twenty-four hours to permit some conclusions to be drawn from a microscopic examination.[2]

A common method of determining the presence or absence of a large quantity of carbon dioxide, for example, at the bottom of a well or privy-vault is to lower a lighted candle to the bottom. If the light is extinguished, the air is considered irrespirable; but, if it continue burning brightly, the air is believed to be sufficiently pure to sustain life. Sulphuretted hydrogen and sulphide of ammonium are sometimes found in privy-vaults, and, although they will not extinguish a light, they speedily prove fatal if inhaled in a concentrated form, and to the exclusion of a sufficiency of oxygen. Cases have frequently occurred where serious or fatal results ensued from the presence of a dangerous gas, which was thought to be excluded by the burning candle.

[1] Recent observations in this country (see Annual Reports of the Surgeon-General of the Navy for 1879, pp. 45 and 46, and the same for 1880, pp. 31 to 34) seem to throw some doubt upon the entire reliability of this method of determining the amount of organic matter in the air examined. Prof. Ira Remsen (Report National Board of Health, 1879, p. 77, and 1880, p. 308 *et seq.*) has shown the insufficiency of the chemical methods at present in use, and points out the difficulties of making trustworthy and satisfactory determinations of organic matter in the air. The great technical difficulties of the various analytical processes render it unwise to burden these pages with a description of them. Only expert chemists are qualified to make a thorough air analysis, and the author does not feel competent to offer advice to them. Dr. Cornelius B. Fox's book on "Sanitary Examinations of Water, Air, and Food," and Flügge's "Lehrbuch der Hygienischen Untersuchungsmethoden" contain detailed descriptions of the best methods employed.

[2] Dr. G. M. Sternberg, U. S. A. (Report National Board of Health, 1880), gives an account of his investigations into the suspended matters of the air. The question is also considered in a practical manner by Surgeons Kidder and Streets, U. S. N., in Reports of the Surgeon-General of the Navy for 1880 and 1881. See also Bacteria, Sternberg and Magnin, 2d ed., p. 197.

[3] See a case reported in Philadelphia Medical Times, October 21, 1882.

It is advisable in all cases to exhaust the stagnant air in old wells and privy-vaults before permitting any one to descend. Perhaps the readiest method of exhausting the vitiated air in such places would be to lower heated stones, masses of hot iron or pails of hot water, to near the bottom, which produce a rarefaction of the air and cause it to ascend. Its place will then be occupied by purer air from without. The rarefaction produced by the explosion of gun-powder has also been made use of with success; but this has some objections, because the combustion of powder itself produces gases which are noxious if breathed in large quantity. An animal, such as a cat or dog, should be first lowered into the suspected well for fifteen or twenty minutes, in order to determine whether the air at the bottom is capable of sustaining life, before permitting the workmen to descend. Similar precautions should be used in old, long-unused mines to prevent fatal effects from the so-called "choke-damp," which is largely composed of carbon dioxide.

PRINCIPLES OF VENTILATION.

During ordinary respiration an adult human being adds 900 grammes = 455,500 cubic centimetres (14 cubic feet) of carbon dioxide to, and abstracts 744 grammes = 516,500 cubic centimetres (16 cubic feet) of oxygen from, the atmosphere in twenty-four hours. Hence, if the individual were confined in an apartment where the inclosed air could not be intermingled by diffusion with the atmosphere without, the proportion of carbon dioxide would soon become so great that the processes of life could not be sustained, and the individual would die. This result would be reached even sooner than the point here mentioned, for the organic matter exhaled from the lungs and the surface of the body would increase the poisonous condition of the air even more than the carbon dioxide given off. It is easily seen, therefore, how important the study of the principles and practice of ventilation becomes in hygiene. In this chapter only the principles underlying this subject can be definitely

stated. Practical details will be more fully given in the chapters devoted to dwellings, schools, hospitals, etc.

It is generally accepted among sanitarians that the presence of .07 per cent. (7 parts in 10,000) of carbon dioxide in the air indicates the greatest amount of organic impurity (from respiration or combustion) consistent with the preservation of health. As each individual gives off from his lungs, in the process of respiration, 316 cubic centimetres of carbon dioxide per minute, the diffusion in the air surrounding him must be sufficiently rapid to keep the air to be breathed at the standard of .07 per cent. above mentioned.

Adopting this as the standard of maximum impurity allowable, 90 cubic metres of fresh air per hour will be needed for each individual to keep him supplied with pure air. This is for a person in a state of health; in cases of disease a more rapid change of air will be necessary to keep that surrounding the patient in a state of purity.

Ventilation is defined by Worcester as "the replacement of noxious or impure air in an apartment, mine, or inclosed space by pure, fresh air from without." By Dr. Parkes the term is restricted to "the removal or dilution, by a supply of pure air, of the pulmonary and cutaneous exhalations of men and the products of combustion of lights in ordinary dwellings, to which must be added, in hospitals, the additional effluvia which proceed from the persons and discharges of the sick. All other causes of impurity of air ought to be excluded by cleanliness, proper removal of solid and liquid excreta, and attention to the conditions surrounding dwellings."[1]

A proper system of ventilation must take into consideration the cubic space of the apartment or building to be ventilated, the number of persons ordinarily inhabiting this space, whether constantly or only temporarily occupied, and certain other collateral elements, such as the character of the building to be ventilated, its exposure, necessity for artificial heating, etc.

[1] Manual of Practical Hygiene, 6th ed., New York, vol. i, p. 157.

The amount of cubic space that must be allowed to each individual is determined by the rapidity with which fresh air must be supplied in order to keep that surrounding the individual at the standard of less than .07 per cent. of carbon dioxide. For example, in a space of 3 cubic metres, the air must be changed thirty times in an hour, in order to prevent the carbon dioxide exceeding the above proportion; that is to say, to allow 90 cubic metres of air to pass through that space in the time mentioned. This would create an uncomfortable, if not injurious, draught. If the space contained 30 cubic metres, the air would need renewal only three times an hour.

A space of 15 cubic metres could be kept supplied with pure air without perceptible movement if all the mechanical arrangements for changing the air were perfect; but such perfection is rarely attainable, and hence there would be either draughts or insufficient ventilation in such a small "initial air-space," as it is termed. The initial air-space should, therefore, be not less than 30, or, better, 40 cubic metres. The air of this space could be changed sufficiently often to keep it at its standard of purity without creating unnecessary draught. For sick persons this should be doubled. In hospitals, therefore, the cubic air-space allowed to each bed should not be less than 60 to 80 cubic metres.

As stated, the purposes for which the building or apartment to be ventilated is employed requires differences in the cubic space and in the volume of fresh air supplied. Morin gives the following table:—

TABLE III.

	Fresh Air Required per Hour per Head.
Hospital wards for ordinary cases,	60–70 cubic metres.
Hospital wards for surgical and obstetrical cases,	100 " "
Hospital wards for contagious diseases,	150 " "
Prisons,	50 " "

Workshops,	ordinary occupations, .	60	cubic metres.
	unhealthy, " .	100	" "
Barracks,	during the day, . .	30	" "
	" " night, . .	40–50	" "
Theatres, ...		40–50	" "
Assembly rooms for long receptions, .		60	" "
" " " brief " .		30	" "
Primary schools, ...		12–15	" "
Higher "		25–30	" "
Stables, ...		180–200	" "

These figures are not excessive from a sanitary stand-point, although few buildings meet the requirements here set down.

The source of the air supplied must, of course, be capable of yielding pure air. It should not be drawn from damp cellars or basements, or from the immediate vicinity of sewers or drains. Air taken from such places is little better for respiration than that which it replaces in the apartments to be ventilated.

Ventilation may be accomplished either with or without artificial aids. In buildings or rooms, used as habitations, natural ventilation (with, perhaps, the simplest mechanical aids) is made use of almost entirely. In large buildings, such as churches, theatres, schools, or in ships and mines, one of the artificial systems must be adopted if efficient ventilation is desired.

Natural ventilation takes place by diffusion, by perflation, and in consequence of inequality of atmospheric pressure. By diffusion is meant the slow and equable entrance of air from without and exit from within a room through the walls or ill-made joints without the influence of wind-currents. In an occupied room this is, however, insufficient to keep the air pure, because many of the organic impurities of respired air are molecular, and, therefore, incapable of making their way out of the rooms through the walls.

Perflation means, literally, "blowing through," and, if the direction and force of air-currents could be regulated, this would, with simple mechanical arrangements, be an efficient means of

ventilation. However, the uncertainty of the force and direction of the wind makes this method of ventilation untrustworthy, except in warm weather.

Unequal pressure between the air in a room and that without is, within certain limits, an efficient means of ventilation, and is usually relied upon in ordinary apartments. When the air in a room is heated above the temperature of the external air, either by a fire, lights, or by the presence of a number of persons in the room, it expands, and part of it finds its way out through numerous crevices and bad joints found in all buildings. The air which remains, being less dense than the external air, the latter enters the room by various openings, until the equality of pressure is re-established. But as the heating of the enclosed air continues, the process is momentarily repeated and becomes continuous.

Although the impurities of respired air (carbon dioxide, organic matter) are heavier than the air itself at the same temperature, it is a familiar fact that the most impure air in an occupied room is always found near the ceiling, the impurities being carried upward with the heated air, and that the pure air from without, being colder, fills the lower part of the room.

If the cold, outside air were to be admitted at the bottom of the room, and means allowed for the escape of the hot air at the top, the conditions of the old health-maxim, to "keep the feet warm and the head cool," would be reversed, This would be no less uncomfortable than unwholesome. In all plans for natural ventilation, therefore, provision must be made to secure a gradual diffusion of the cold, outside air from above, or to have it warmed before it enters the room. With a large chimney as an aspirating shaft,[1] with flues at the top and bottom of the room, and openings in the walls of the room near the ceiling to admit fresh air, sufficient ventilation can be usually secured in cold weather, in a room not overcrowded.

[1] Of course there is really no such thing as a real aspiration, or "sucking out" of the air through the chimney or so-called "aspirating shaft." The upward movement of the air in the shaft is due to its displacement by the colder or denser air entering the room.

When a room is heated by a furnace, the fresh air is warmed before it is introduced, and the foul air escapes either through a ventilating shaft, a ventilator in the window or wall, or through the numerous fissures and other orifices which defective carpentering always leaves for the benefit of the health of the occupants.

The following rules for the arrangement of a system of natural ventilation are modified and condensed from Parkes[1]:—

The apertures of entrance and of exit for the air should be placed far enough apart to permit thorough diffusion of the fresh air.

When the air is brought into a room through slits or tubes in the walls near the ceiling, the current should always be deflected upward by an inclined plane, in order to prevent a mass of cold air from descending over the shoulders of the occupants and chilling them.

The air must be taken from a pure source.

The inlet-tubes should be short, and so made as to be easily cleansed, otherwise dirt lodges and the air becomes impure.

Inlets should be numerous and small, to allow a proper distribution of the entering air.

Externally, the inlets should be partially protected from the wind to prevent strong draughts; they should also be provided with valves to regulate the supply of air.

If the air cannot be warmed, the inlets must be near the ceiling; if it can be heated, it may enter near the floor.

The air may be warmed by passing it through boxes containing hot water or steam coils, by passing it through chambers around grates or stoves, or heating it in a furnace.

In towns or manufacturing districts the air should be filtered before allowing it to enter the room. Thin flannel or muslin spread over the openings answers very well as filtering material.

Outlets should be placed at the highest point of the room

[1] Manual of Practical Hygiene, 6th ed., New York, vol. i, p. 177.

and should be protected from the weather. An opening into the chimney near the ceiling will answer well in many cases.

In one-story buildings, ridge-ventilators make the best outlets. The entrance of snow and rain must be prevented by suitable arrangements.

A small space or slit between the horizontal bars of the upper and lower window-sash will admit sufficient air in a proper direction in small rooms, even when the window is shut.

In all rooms, howsoever ventilated, doors and windows should be often opened to permit a thorough *flushing* of the interior with fresh air.

For large buildings, hospitals, schools, theatres, ships, and mines two systems of artificial ventilation are in use. One operates by extracting the foul air by means of fans, the other by forcing in fresh air, allowing the impure air to find its way out as best it may.

Further details upon the practical application of these principles will be given in succeeding chapters of this work.

[In addition to the works mentioned in the text the following may be referred to as more fully treating of the subjects considered in this chapter:—

Flammarion: The Atmosphere.—The Articles on Atmosphere and Climate in the Encyclopædia Britannica, 9th edition.—Reports of the Chief Signal Officer of the Army.—A paper on Climate and Diseases, by Dr. Cleveland Abbe, in Report of National Board of Health for 1880.—Die Canalgase, by Dr. F. Renk, Munchen, 1884.—Morin: On Warming and Ventilating Occupied Buildings; translated in Smithsonian Report for 1873 and 1874.—V. Pettenkofer und Ziemssen's Handbuch der Hygiene, I Theil, 2 Abtheilung. Die Luft, by Dr. F. Renk.]

CHAPTER II.

Water.

Physiologists teach that nearly two-thirds of the tissue of the animal body consists of water. Inasmuch as this water is constantly being lost by evaporation from the skin, exhalation by the lungs, and excretion through various organs, it is evident that the loss must be constantly supplied if the functions of life shall be properly performed.

It appears probable that certain diseases are at times spread through the agency of insufficient or impure drinking-water. It is, therefore, a matter of very great importance to have a definite notion of what constitutes a pure and sufficient supply of water, and how best to secure it, to be able to detect its conditions of purity and impurity, and to know how to maintain the former and avoid the latter. It will be necessary to consider in detail, therefore, the quantity of water required by each individual for the maintenance of health, the sources whence water is obtained, how it should be collected and stored to the best advantage, the impurities likely to be contained in it, and the methods of keeping it pure, or of purifying it when it has become polluted or vitiated in any manner.

THE QUANTITY OF WATER REQUIRED BY HUMAN BEINGS.

Dr. Parkes, after a number of experiments, concluded that a man of the English middle class, "who may be taken as a fair type of a cleanly man belonging to a fairly cleanly household," uses about twelve gallons of water per day. This covers all the water needed, including a daily sponge bath. Dr. DeChaumont estimates[1] that 16 gallons should be the daily

[1] Parkes' Hygiene, 6th ed., New York, vol. i, p. 5.

allowance. By order of the British War Department, 15 gallons of water are allowed to each soldier daily. In very many instances this quantity cannot be furnished, but in such cases there necessarily results some deficiency in cleanliness. It is probable that among the poorer classes, especially where a large supply of water is not convenient, the quantity used is not over one-fourth of the above estimate.

In estimating the daily supply of water needed in a community, large or small, other circumstances must be taken into consideration in addition to the demands of the individual. For example, in towns or cities allowances must be made for animals, manufacturing purposes, probable waste, fires, sewerage, etc. In cities an allowance of 50 gallons daily per head would not be excessive. In most American cities the supply is much greater.[1] The present daily supply in Baltimore, which is derived from an excellent source, is estimated at 60 gallons per head, which could be increased to three times that quantity if necessary.

A serious problem, affecting, however, the engineer rather than the sanitarian, is the prevention of waste of water in places where the supply is limited. It is estimated that in Chicago one-half of the water pumped is wasted through negligence and imperfections in the supply apparatus, while in St. Louis the annual cost to the city of the water that is wasted is placed at $400,000. It has been proposed to check this wanton waste by measuring the quantity of water used by each household by means of a meter, as the supply of gas is now measured, and this has been carried into effect in places. There are, however, serious objections to this method. One of the objections is that the very class of persons whom it is desired to induce to use a plentiful supply of water would, from motives of economy, use less than is necessary for cleanliness and health. A system of vigilant inspection of the water service in houses would probably serve to reduce this unnecessary waste to a considerable extent.

[1] Buck's Hygiene and Public Health, vol. i, p. 214.

SOURCES OF DRINKING-WATER.

All water, from whatever direct source obtained, comes originally, by precipitation, from the atmosphere. In many places the rain- or snow- water is the only source of supply. This is usually collected as it falls upon the roofs of buildings and conveyed by gutters and pipes to cisterns, where it is stored until needed.

In Venice, the rain falling upon the streets and court-yards is also collected in cisterns after filtering through sand. The cisterns used for the storage of water in New Orleans and other Southern cities in the United States, where the temperature rarely falls below the freezing-point, are generally constructed of wood and placed above-ground. Farther north, where it is necessary to protect them against the action of frost, they are placed under-ground. These under-ground cisterns are usually built of brick. The water from cisterns above-ground becomes very much heated in summer, and necessitates the use of large quantities of ice to make it palatable. The water from the under-ground cisterns is pleasantly cool in summer, and is also guarded against freezing in winter, There are, however, very serious objections to storing drinking-water in under-ground cisterns. These reservoirs are usually placed within a few feet of privies and cess-pools, and, as neither the retaining walls of the cisterns nor those of the privies are water-tight, it often happens that the drinking-water becomes strongly impregnated with the soluble portions of the excrement, or the products of its decomposition, which have drained into the cistern. Personal observations in Memphis in 1879, as well as the careful chemical analyses made afterward by Dr. Chas. Smart, U. S. A.,[1] have convinced the author that the objections to all under-ground cisterns built of brick, stone, or cement are insuperable from a sanitary point of view. Dr. Smart found over one-half of the under-ground cisterns examined by him in Memphis and

[1] Report National Board of Health, 1880, pp. 437–441.

other cities and towns to be leaky and presenting evidence of organic pollution. The water from 31 out of 80 cisterns analyzed showed decided contamination by sewage. It would seem advisable to prohibit all under-ground cisterns for the storage of drinking-water unless they are constructed of iron, which should be protected against oxidation by a thorough coating of coal-tar. Where any other system of collection and storage is available, however, the under-ground cistern should be unreservedly condemned.

Rain-water collected in the country, away from manufacturing districts, is usually quite pure and wholesome. Its taste is, however, flat and insipid, owing to absence of carbon dioxide and mineral constituents. In cities rain-water frequently contains such a large amount of organic matter and other impurities, which have been washed out of the air by the rain, that it may be unfit for drinking. On account of its softness, rain-water is very desirable for washing and other domestic purposes. If the statement made in the last chapter, concerning the presence of organisms in the atmosphere, is remembered, it will be evident on a moment's thought that such organisms, when contained in rain-water, may be the source of disease. The putrefaction which so readily takes place in rain-water upon standing a few days is caused by certain of the organisms carried down out of the lower strata of the air by the descending rain or snow.

Precipitation is an exceedingly untrustworthy source of water, and should never be depended upon when other sources of supply are available. Water famines are frequent wherever people are compelled to rely upon such an uncertain source of supply as rain or snow.

Rivers and smaller streams probably supply the larger number of cities and towns in this country with drinking-water. When care is taken to prevent the pollution of the stream above the point whence the water is taken, this is usually of fair quality for domestic purposes. When the river can be tapped near its source, or before a large number of manufacturing

establishments can empty their waste products into its current, or before it receives the sewage of a considerable number of inhabitants living on its banks, the water can generally be regarded as safe. It is very difficult, however, except in the less settled portions of the country, to find these favorable conditions present.

Among the minor objections to the use of river-water for domestic purposes are the liability of most streams to become turbid in times of freshet, and the discoloration of the water from dissolved coloring-matters if the stream flows through a marshy or peaty region. These objections are, however, not serious, as filtration will readily remove the suspended matters. The coloring-matter is probably harmless. The organic matter contained in the water of some streams, even when pollution by sewage and manufacturing refuse is absolutely excluded, may, however, be the cause of disease. Dr. Smart has shown[1] that the water from streams in Nebraska, Wyoming, and Utah contained organic matter varying in amount from .16 to .28 parts per million.[2] He thinks the so-called "mountain fever" of the Rocky Mountain region is a malarial fever caused by the large amount of organic matter in the drinking-water.

Dr. G. M. Kober, U. S. A., states that he has frequently drunk water from mountain streams which had a perceptible taste of cattle-manure, and suggests that as the origin of the ammonia found by Dr. Smart in the water of mountain streams. Dr. Kober also regards the "mountain fever" as a typhoid fever with malarial complications.[3]

The most serious objection to the use of river-water for domestic purposes is the employment of streams as carriers of refuse from manufacturing establishments, or of the sewage of cities and towns. In Great Britain and some parts of the continent of Europe, owing to the density of population and the

[1] American Journal Med. Sciences, January, 1878, p. 28 *et seq.*

[2] The source of this organic matter seems to be the melted snow which makes up a large portion of the streams.

[3] Report of California State Board of Health for 1886, pp. 48 and 177.

variety and extent of manufacturing industries, many of the streams are in an extremely filthy condition. In this country, too, especially in the more thickly settled manufacturing districts of New England, the pollution of rivers has increased to a degree to seriously jeopardize the health of the people who are compelled to draw their water-supply from such streams. Several years since a commission was appointed by the State Board of Health of Massachusetts to inquire into the extent of the pollution of the streams in that State, and to devise means for preventing such pollution. The commission extended its inquiries and observations over several years, reporting the result to the State authorities at intervals.[1] It was found that the water of the Blackstone River, at Blackstone, where it crosses the State line and enters Rhode Island, contained over 10 per cent. of sewage and refuse waters.[2] Other streams in Massachusetts show similar pollution. That the presence of such excessive contamination renders the water unsuitable for domestic purposes must appear evident. It is probable, however, that the most dangerous of the polluting matters are the excreta of human beings, especially those of patients suffering from certain specific diseases, such as typhoid fever or cholera.

Only a few years ago it was a generally-accepted theory that running-water, though polluted by sewage, "purified itself" after flowing a distance of twelve miles, and the comforting and reassuring doctrine is still held by many. Recent observations point to the conclusion, however, that the self-purification of rivers is not entirely to be relied upon. A certain proportion of the sewage, it is true, undergoes oxidation in the presence of light and air and minute organisms,[3] and so becomes changed into other, possibly innocuous compounds. But at present it is not known what proportion or what kind of organic matter does undergo this change. Another portion of the impurities is deposited upon the bottom and sides of the stream, having

[1] Reports State Board of Health of Massachusetts for 1873, 1874, 1876, 1877, 1878, 1879, 1880.
[2] Report State Board of Health of Massachusetts, 1876, p. 145.
[3] Disinfection, in Eulenburg's Realencyclopædie d. ges. Heilkunde, vol. iv, p. 68.

been only held in suspension, and not dissolved in the water. A portion probably forms chemical combinations with other suspended or dissolved matters, and is changed into compounds which may be volatile and pass off into the air, or form insoluble precipitates.

The remainder is rendered less perceptible or imperceptible to chemical means by dilution. Every stream has sources of inflowing water—feeders—which increase its volume, and thus dilute any foreign admixture.

In view of these facts, the theory of the self-purification of streams, as formerly held, can no longer be regarded as true. But it is unquestionably true that running-water does regain its purity if the inflow of sewage and other refuse is not excessive. It cannot be stated with confidence, however, when a stream, once polluted, becomes fit to use again. Moreover, as it is not possible, by any practicable chemical treatment or filtration on a large scale, to make a polluted water absolutely wholesome, it is safer not to use as a source of domestic supply a stream which is known to have been seriously contaminated by sewage matters or other impurities.

The water from fresh-water lakes and ponds is generally to be preferred to river-water for domestic use. It is less liable to become turbid from time to time, and, except in the case of small ponds, inflow of sewage is not likely to cause fouling of the water to any serious extent. When the supply can be drawn from large lakes, as is done in Chicago and other cities on the great lakes of the United States, no purer or better source can be desired. In these cases the point whence the water is taken should be far enough from shore to avoid possibility of sewage contamination. When the water-supply is taken from small ponds, all sewage and waste products from houses and factories must be rigidly excluded; otherwise, diseases attributable to the polluted water are likely to arise among those using the same.

The water in small lakes and storage reservoirs sometimes

becomes offensive in taste and odor. The water-supplies of several of the large Eastern cities have within the past seven or eight years at times had a peculiar odor and taste somewhat resembling cucumbers. After considerable study, Prof. Ira Remsen, of Baltimore, found the cause of this odor and taste in a minute fresh-water sponge, the *Spongilla fluviatilis*. A still more offensive odor, tersely described as the "pig-pen odor," is given to the water by the decay of certain species of nostoc and other algæ. It is not known that either these vegetable or animal organisms, if present, render the water prejudicial to health.

Ponds are often used as sources of ice-supply. It was formerly supposed that in the process of freezing, solid matters in the water were not included in the block of ice when congelation occurred. Recent observations have shown the falsity of this assumption. In 1875, an outbreak of acute intestinal disease at Rye Beach, New Hampshire, led to an inquiry by Dr. A. H. Nichols, which disclosed the fact that the ice used contained a large percentage of organic matter.[1] The use of ice from a different source was followed by an almost immediate disappearance of the disease. Upon further investigation it was discovered that the impure ice had been gathered from a small, stagnant pond into which a small brook carried large quantities of saw-dust from several saw-mills. The water of the pond was loaded with organic matter, and in summer the gases of decay arising from it were very offensive. Chemical examination showed that the ice from this pond contained nearly 6 parts of organic matter in 100,000, while in pure ice the organic matter amounted to only .3 part in 100,000. A similar investigation into the character of the ice furnished to the residents of Newport, R. I., was made under the auspices of the Sanitary Protection Association of that city. The ice, which was cut from ponds in the immediate neighborhood of the city, was found to contain an excessive proportion of organic matter.

[1] Report Massachusetts State Board of Health, 1876, p. 467.

Large quantities of sewage and other impurities were discharged into these ponds.[1]

A series of experiments recently made by Dr. C. P. Pengra, of Michigan, shows[2] that the purification of the water by freezing is in no sense absolute. In experimenting with bacteria, infusoria, and other organisms, he found that from 9 to 11 per cent. remained in the ice and retained their vitality, so that when thawed they rapidly multiplied, and there was no apparent loss of numbers. In the ordinary process of freezing the upper portion is the purest, but if snow or rain fall upon the ice and freeze this upper layer will be found much more impure than the lower. Rational conclusions from these experiments are, that ice should not be gathered from an impure source, and that an early harvest of the ice should be encouraged.

In a very recent research, Prudden has shown that typhoid bacilli contained in water are not entirely destroyed by freezing, even after remaining in this condition for 103 days.

Springs and wells supply the water for most persons not aggregated in large communities, as cities and towns. Even in the latter no inconsiderable quantity of the water used for drinking and domestic purposes is derived from wells. Spring-water usually comes from a source at a considerable depth below the surface; that is to say, the water has percolated through thick strata of soil before re-appearing at the surface. In its passage through the soil it has lost most of its organic matter, and perhaps taken up mineral and gaseous constituents in larger quantities. It may be so strongly impregnated with the latter as to vitiate it for ordinary use and to render it valuable as a medicine. Ordinarily, however, spring-water is clear, cool, and sparkling, with a refreshing taste and uniform temperature, and in all respects an agreeable and wholesome beverage.

The character of well-water, on the contrary, is often justly open to grave suspicion. Being derived from those strata of the

[1] The Dangers of Impure Ice, in The Sanitarian, May, 1882.

[2] Private communication to the author. The memoir of Dr. Pengra has been published in the Report of the Michigan State Board of Health for 1884.

soil which are most likely to be contaminated by the products of animal and vegetable decomposition, the wholesomeness of the water is inversely proportional to the degree of saturation of the soil with the products of decay. It has been found by experiment that, when organic matter largely diluted with water is allowed to percolate through soil, it undergoes a gradual decomposition in the presence of certain minute organisms, nitrates and nitrites being formed at the expense of the ammonia and other organic combinations. If, however, the soil is saturated with organic matter in excess, and in a state of concentration, putrefaction takes place, and the conversion of the organic matter into nitrates and nitrites is retarded. Hence, the drainage of diluted sewage through a stratum of porous soil, not already saturated with putrefying matters, has no especially bad significance, even if the liquid should reach a well used as a source of drinking-water. It is probable that by the time the liquid portion of the sewage reached the well it would have arrived at that point when it could truthfully be termed pure water. At the same time it must be remembered that the purifying power of the soil cannot be relied upon if the supply of sewage or other animal or vegetable impurity is too abundant.

Distillation is sometimes resorted to for the purpose of procuring drinking-water, especially at sea. Vessels now generally carry a still for this purpose. The principal objection to distilled water is its insipidity, due to the absence of carbon dioxide and mineral constituents, which give to good drinking-water its savor. Distilled water may be aërated by passing it in fine streams through holes in the bottom of a cask, elevated so as to allow the water to pass through a considerable stratum of air. Lead is sometimes taken up from the distilling apparatus, and may cause lead poisoning in those using the water.

Drinking-water is sometimes procured by melting snow or ice. It is not probable that water derived from these sources is unwholesome, although there is strong popular prejudice against it. Ice and snow may, however, contain large amounts of

impurities, as already referred to,[1] and be for this reason unfit for use.

The following qualities are desirable in water for drinking and domestic purposes:—

1. The water should be colorless, transparent, sufficiently aërated, of uniform temperature throughout the year, and without odor or decided taste.

2. The mineral constituents (magnesium and lime salts) should not be present in greater proportion than 4 or 6 parts per 100,000. More than this gives to water that quality known as "hardness."

3. There should be but little organic matter present, and no living or dead animal or vegetable organisms.

4. The water should be entirely free from ammonia and nitrous acid, and should contain but very small quantities of nitrates, chlorides, and sulphates.

5. It should contain less than one milligramme of lead per litre. A larger proportion is likely to be followed by lead poisoning.

IMPURITIES IN WATER.

The transparency and the color of water are affected by the presence of suspended or dissolved mineral or organic matters. If, after standing for a time, the water deposits a sediment, this is dependent upon insoluble matters. If the sediment turns black when heated in a porcelain capsule over an alcohol or gas flame it contains organic matter. If the sediment or residue effervesces upon the addition of hydrochloric acid the presence of carbonates is indicated. Water may be colored by metallic salts or by vegetable matter. It may also contain large quantities of mineral or organic matter, or even living organisms, without perceptibly diminishing its transparency. For example, the ova of tape-worms may exist in water in considerable numbers, and yet remain perfectly invisible except under the microscope.

[1] See pages 52 and 53.

The presence of sulphur compounds, or of various vegetable and animal organisms (sponges, algæ, etc.[1]), may give to water an unpleasant odor and taste. In the oil regions of this country most of the drinking-water is contaminated with petroleum, which is very disagreeable to one unaccustomed to it. It is not probable that the small quantities of the oil imbibed with the water have any deleterious influence upon the organism.

Many works on hygiene fix a limit to the amount of solid matter allowable in drinking-water. The International Congress of Hygiene, at Brussels, fixed the limit at 50 parts in 100,000. It is impossible, however, to say of any particular specimen of water that its content of solid matter, whether organic or mineral, will be prejudicial to health without trial. At the same time it is prudent to reject all waters containing a considerable proportion of solid organic matter, as determined by the degree of blackening on heating the sediment or residue after evaporation.

The hardness of water is due to the presence of earthy carbonates, or sulphates, or both. If the hardness is due to carbonates it is dissipated by heat, as in boiling the water; the carbon dioxide is driven off, and the base (calcium or magnesium oxide) is precipitated upon the bottom and sides of the vessel. This is termed the "removable hardness." The hardness due to the presence of earthy sulphates is not removed upon heating the water, and is termed the "permanent hardness." The hardness depending upon both the carbonates and sulphates is called the "total hardness."

The proportion of the above-mentioned earthy salts present in a given specimen of water is determined by what is called the soap test. This test depends upon the property which lime and magnesia salts possess of decomposing soap (oleate and stearate of soda). The quantity of a solution of soap of a definite composition decomposed by a quantity of hard water indicates the amount of the salts present. In this country and England this

[1] See page 52.

is generally expressed in degrees of Clark's scale, which are equivalent to grains of carbonate of lime per imperial gallon. Thus, if the chemist says that a certain sample of water has a total hardness of 16 degrees he means that the earthy salts in the sample decompose the same quantity of soap that would be decomposed by 16 grains of carbonate of lime per imperial gallon. In Germany each degree of the scale used expresses the soap decomposed by 1 part of calcium oxide per 100,000. In the scale used in France each degree corresponds to 1 part of carbonate of lime in 100,000. So much of the hardness of water as is due to carbonates can be dissipated by boiling, which drives off the free carbon dioxide and allows the insoluble oxides to be deposited as an incrustation upon the bottom and sides of the vessel.

The standard soap solution for testing the hardness of water is made as follows: Dissolve 10 grammes of Castile soap in a litre of weak (35 per cent.) alcohol. One cubic centimetre of this solution precipitates 1 milligramme of carbonate of lime. The test is made as follows: To a definitely-measured quantity of water (say 100 cubic centimetres) in a graduated burette a quantity of the soap solution is added and the mixture shaken up; so long as there are dissolved lime or magnesium salts in the water the soap is decomposed and no lather is formed. Soap solution is now added gradually and the shaking repeated until there is evidence of saponification by the formation of a more or less permanent lather or froth. The quantity of soap solution used is noted, and the test is repeated. The mean of the quantity of soap solution in cubic centimetres used in the two experiments will represent approximately the proportion of salts in grains of carbonate of lime per gallon present, or, as it is generally expressed, in "degrees of hardness."

The scale on the following page shows the quantity of soap solution required to decompose the proportion of calcium oxide per 100,000.[1]

[1] Uffelmann, Handbuch der Hygiene, p. 94.

TABLE IV.

1	part	CaO	per	100,000	water	requires	5.4	c.cm.	standard	soap	solution.
2	parts	"	"	"	"	"	9.4	"	"	"	"
3	"	"	"	"	"	"	13.2	"	"	"	"
4	"	"	"	"	"	"	17.0	"	"	"	"
5	"	"	"	"	"	"	20.8	"	"	"	"
6	"	"	"	"	"	"	24.4	"	"	"	"
6.5	"	"	"	"	"	"	26.2	"	"	"	"
7.0	"	"	"	"	"	"	28.0	"	"	"	"
7.5	"	"	"	"	"	"	29.8	"	"	"	"
8.0	"	"	"	"	"	"	31.6	"	"	"	"
8.5	"	"	"	"	"	"	33.3	"	"	"	"
9.0	"	"	"	"	"	"	35.0	"	"	"	"
9.5	"	"	"	"	"	"	36.7	"	"	"	"
10.0	"	"	"	"	"	"	38.4	"	"	"	"
10.5	"	"	"	"	"	"	40.1	"	"	"	"
11.0	"	"	"	"	"	"	41.8	"	"	"	"
11.5	"	"	"	"	"	"	43.4	"	"	"	"
12.0	"	"	"	"	"	"	45.0	"	"	"	"

If there are more than 12 parts of lime in 100,000 the water is diluted with an equal proportion of distilled water and the resultant multiplied by two.

Mr. Wynter Blyth has proposed to take the total residue as representing approximately the total hardness of the water, but Dr. Fox points out that there may be a large excess of inorganic solids present in water that is quite soft and originally pure.

Hard water is objectionable for domestic use, as it is wasteful of soap. In cooking certain vegetables, such as peas and beans, the hulls are not thoroughly softened. In making infusions of tea and coffee, larger quantities of these materials are needed than where soft water is used.

DISEASES DUE TO IMPURE DRINKING-WATER.

Hard water is popularly believed to be the cause of calculous diseases, and of goitre and cretinism, but no reliable observations are on record showing that the belief is founded upon

fact. At the same time it is undoubtedly true that calcareous waters produce gastric and intestinal derangements in those unaccustomed to their use.

Large amounts of suspended mineral matter are frequently present in river-water, and may give rise to derangements of the digestive organs. If there is carbonate of lime present, the water can be easily clarified by the addition of a small quantity of alum. Sulphate of lime and a bulky precipitate of hydrate of alumina are formed, which carry the suspended matters to the bottom. About 10 centigrammes of crystallized alum are sufficient to clarify a litre of water. This amount of alum is too small to affect the taste of the water perceptibly. This method is frequently used to clarify and render fit for use the water of the Mississippi River, which is usually very muddy. Dr. Parkes quotes the following striking instance of the practical value of clarifying muddy water by means of alum.[1] In 1868 the right wing of the Ninety-second Regiment of Highlanders, going up the river Indus, suffered from diarrhœa from the use of the water, which was very muddy. The left wing of the same regiment used water from the same source, but precipitated the suspended matters with alum and had no diarrhœa. The right wing then adopted the same plan with like success. Although the opinion is widespread that water containing much mineral matter, either in solution or in suspension, is deleterious to health, there is very little evidence absolutely trustworthy upon this point.

The presence of large quantities of organic matter in water, whether these matters be of animal or vegetable origin, must always be looked upon with suspicion. The observation was made by Hippocrates twenty-three centuries ago, that persons using the water from marshes, *i.e.*, water containing vegetable matter, suffer from enlarged spleens. Many physicians, both of ancient and modern times, seem to have held this opinion, but the first positive observation in medical literature is the now

[1] Manual of Practical Hygiene, 6th ed., New York, vol i, p. 341.

classical one of the ship *Argo*, reported by Boudin.[1] In 1834 the transport *Argo*, in company with two other vessels, carried 800 soldiers from Bona, in Algiers, to Marseilles. The troops were all in good health when they left Algiers. All three of the vessels arrived in Marseilles on the same day. In two of them there were 680 men, not one of whom was sick. Out of the remaining 120 men who were on the third vessel, the *Argo*, 13 died during the passage, and 98 of the 107 survivors suffered from paludal fevers of all forms. None of the crew of the *Argo* were sick, however. The two vessels exempt from sickness, and the crew of the *Argo*, had been supplied with pure water, while the soldiers on the latter vessel had been furnished with water from a marsh. This water was said to have a disagreeable odor and taste. The testimony of a large number of East India physicians is also quoted by Parkes in support of the view that malarial fevers are often caused by impure drinking-water. The observations of Dr. Charles Smart, upon the production of "mountain fever" of the Western territories, have already been referred to. The author ventures to state it as his opinion, however, that the instances in which malarial fevers are due to impure drinking-water are very rare.

The causation of typhoid fever and cholera by impure drinking-water will be presently referred to. Recently the opinion has been expressed by some that yellow fever and diphtheria are also spread by polluted drinking-water, but no strong evidence has yet been adduced in its support.

There can be very little doubt that diarrhœa and dysentery are frequently caused by water which has been contaminated with decaying organic matter. The evidence in favor of this amounts practically to demonstration.

It must not be forgotten that the ova of certain animal parasites, such as distoma hematobium, filaria sanguinis hominis, and medinensis, anchylostoma duodenale, and possibly of round-

[1] Quoted in Parkes, *op. cit.*, p. 48; Nowak, Lehrbuch der Hygiene, p. 51; and in numerous other publications on Hygiene.

and tape- worms, for example, are taken into the system along with the drinking-water.

Organic detritus of various kinds, sewage, decomposing animal and vegetable matter, refuse from manufacturing establishments, may be a source of pollution of water and render it unfit for drinking or other domestic purposes. It is, however, not certain that water thus rendered unclean is prejudicial to health; in fact, Dr. Emmerich, of Munich, has recently put his skepticism on this point to a practical test. For two weeks he drank daily from half a litre to a litre of very filthy water; in fact, nothing less than sewage. The water was both chemically and physically exceedingly impure. Several of the experimenter's patients partook of the same water without any ill effect. He even claims that a gastric catarrh, from which he was suffering when the experiment was begun, was improved during its course.[1]

The results of Emmerich's experiments, and of other well-known observations, seem almost conclusive that the products of animal and vegetable decomposition, taken into the body with the drinking-water, cannot be looked upon as certainly harmful. Should, however, water containing such impurities, or even water apparently pure, contain the germs of one of the specific diseases,—cholera, typhoid fever, or, perhaps, yellow, malarial, or scarlet fevers, or diphtheria,—it is probable that such diseases would be communicated to the consumer of the water.

Many instances are on record where outbreaks of typhoid fever have been clearly attributable to pollution of the drinking-water by the germ of the disease from a previous case.

One of the most remarkable of these outbreaks is that recorded by Dr. Thorne.[2] About the end of January, 1879, typhoid fever began suddenly in the adjoining towns of Caterham and Red Hill. Within six weeks 352 cases occurred. All

[1] Wolffhuegel: Wasserversorgung, in Pettenkofer u. Ziemssen's Handbuch der Hygiene, I Abth., II Hlfte, p. 97.

[2] Report of the medical officer to the Local Government Board for 1879. Quoted in Fodor: Hygienische Untersuchungen, etc., II Abth., p. 261.

other sources of the disease were excluded except the drinking-water, to pollution of which it was traced with almost absolute certainty. Caterham contained 558 houses and Red Hill 1700. Of the former 419 and of the latter 924 drew their drinking-water from a common supply, having its source in a well several hundred feet deep. The insane asylum, with 2000 inmates, and the military barracks in Caterham used water from a private well. There was no typhoid fever among the last two communities. During January one of the workmen engaged in some excavation near the public well was taken ill with diarrhœa and fever,—probably typhoid,—but was still able to continue his work. His dejections were often voided where they were certain to become mingled with the water of the common supply. This man's diarrhœa began on January 5th and continued until the 20th of the month, during which time he remained at work. On the latter date he was compelled to quit work and take to his bed. Exactly two weeks from the beginning of the man's sickness, on January 19th, the first case of typhoid occurred in Caterham, and then rapidly increased. The first case occurred, therefore, just fourteen days—the incubative period of typhoid—after the presumed infection of the drinking-water by the dejections of the sick laborer, who had come from Croydon, where typhoid fever was at the time prevalent. Within two weeks from the appearance of the first case the epidemic had reached its height, and then rapidly declined, disappearing almost entirely in a month after the outbreak. It was shown by Dr. Thorne that nearly all the houses in which the disease appeared were supplied with water from the source above mentioned, while other houses in the immediate vicinity of the infected ones remained free from the disease.

In 1874 there was an outbreak of typhoid fever in the town of Over Darwen, in which nearly 10 per cent. of the inhabitants were attacked. Here the source of the disease was also traced to an infected water-supply.

Dr. Buchanan has shown that an outbreak among the stu-

dents of the University of Cambridge was likewise attributable to an infected water-supply.

In this country the reports of the Boards of Health of the various States teem with accounts of localized outbreaks of typhoid fever, referred to infected or polluted drinking-water. In most instances the evidence furnished by the observers is not conclusive. In many, however, especially of those found in the Massachusetts and Michigan reports, the fact of the communication of the disease in this manner seems unquestionable. One of these is as follows: Out of 40 families, all using water from a certain well, there occurred 23 cases of typhoid fever. Out of 47 families, living in the same neighborhood, but using water from different sources, only 2 had typhoid fever.[1] Dr. C. F. Folsom has published a very suggestive account of a house epidemic,[2] where 9 persons in a single house, who all drank water from a well which was proven to be infected from a privy, were attacked by this disease.

In 1885 an epidemic of typhoid fever began in Plymouth, a mining town of 8000 or 9000 inhabitants, situated in the Wyoming coal region of Pennsylvania, and on the right bank of the Susquehanna River. The epidemic began in April, and lasted until the ensuing September. There were 1104 persons attacked by the disease, of which number 114, or 10.3 per cent., died. The careful inspection made into the history of this epidemic revealed the fact that the public water-supply had unquestionably become polluted by the fæcal discharges of typhoid-fever patients, and the entire course of the disease, in this instance, is in complete accord with the view that the origin and spread of the epidemic were due to the pollution of the drinking-water with the typhoid-fever poison.

In addition, Chantemesse and Vidal have demonstrated the presence of the bacillus of Eberth, which is now generally recognized as the cause of typhoid fever, in drinking-water from

[1] Transactions Mich. Med. Society, p. 401, 1883.
[2] Boston Med. and Surg. Journal, vol. cii, pp. 227, 261.

a well near Paris, to which a small outbreak of typhoid had been traced. This demonstration has also been furnished by Prof. V. C. Vaughan, in connection with an outbreak of the same disease in the State of Michigan.

The numerous cases of typhoid fever which have been attributed to the use of infected milk may be included in this category. It is probable that the milk became infected either through polluted water used for the purpose of cleansing the milk-vessels or in diluting the milk. Mr. Ernest Hart has recorded[1] 50 epidemics of typhoid fever, 15 of scarlet fever, and 7 of diphtheria, the cause of which he has attributed to infected milk.

It is probable that typhoid fever is, in the majority of cases, spread through the medium of polluted drinking-water, and, in many of the instances on record, the relations between cause and effect—impure water and typhoid fever—have been so clearly made out as to no longer permit any doubt upon the question.

As it is with typhoid fever, so also with cholera. In a later chapter the origin and propagation of typhoid fever and cholera will be discussed more fully. At the present time only the relations of the drinking-water to the spread of these diseases can be considered. In the instance to be presently noted the connection between the infected water, on one hand, and the outbreak of cholera, on the other, is so clearly shown as to be almost equivalent to a mathematical demonstration. The facts in the case were brought to light after a patient inquiry by a commission, whose report drawn up by Mr. John Marshall has made the occurrence classical. In 1854 the people of a well-to-do and otherwise healthy district in the eastern part of London suffered severely from cholera. Upon inquiry the fact was elicited that a child had died of cholera at No. 40 Broad Street, and that its excreta had been emptied into a cess-pool situated only three feet from the well of a public pump in that street, from which most of the neighboring people took their drinking-

[1] Transactions Seventh Int. Med. Congress, vol. iv, p. 391, 1881.

water. It was further discovered that the bricks of the cess-pool wall were loose and permitted its contents to drain into the pump-well. (It should be noted that the communication between the cess-pool and well was direct; that there was immediate drainage, not percolation through the soil.) In one day 140 to 150 people were attacked, and it was found that nearly all the persons who had the malady during the first few days of the outbreak drank the water from the pump. When the pump was closed to public use by the authorities the epidemic subsided. The most singular case connected with this outbreak was the following: In West End, Hampstead, several miles away from Broad Street, there occurred a fatal case of cholera in a woman 59 years old. This woman formerly lived in Broad Street, but had not been there for many months. A cart, however, went daily from Broad Street to West End, carrying, among other things, a large bottle of water from the pump referred to. The old lady preferred this water to all others, and secured a daily supply in the manner stated. A niece, who was on a visit to the old lady, drank of the same water. She returned to her home, in a high and healthy part of Islington, was likewise attacked by cholera and died. There were, at this time, no other cases of cholera at West End, nor in the neighborhood of these last two persons attacked.

Most of the English medical officers in India hold strongly to the view that cholera is spread by polluted drinking-water, and the evidence in its favor is very strong.

Quite recently (in 1885) Dr. Robert Koch discovered the cholera spirillum in a water-tank in Calcutta, used as a source of domestic supply, and in this way furnished another link in the chain of evidence connecting the spirillum, the drinking-water, and the outbreak of the disease.

The evidence in favor of the influence of impure drinking-water on the causation of other diseases than those mentioned is not sufficient to justify any conclusions at present.

The source of a water-supply may be pure, yet pollution

may occur before the water is used by the persons to whom it is distributed. Supply-pipes may become defective, and the water become contaminated with sewage or other deleterious substances. It is a current belief that no impurity can gain access to hydrant-pipes between the reservoir, or source of supply, and the point of discharge of the water. Nevertheless, such contamination may occur very readily. The author and his colleague, Dr. J. W. Chambers, of Baltimore, proved this conclusively a few years ago by establishing an undoubted connection between a house-epidemic of typhoid fever and a defect in the hydrant supplying the family with water.[1] The hydrant was one of the class known as Clark's patent non-freezing hydrant. The mechanism of these hydrants is as follows: At the lower end of the vertical discharge-pipe is a glazed earthenware plunger, which works through a ring of rubber packing into a vacuum chamber. At the bottom of the vacuum chamber is a valve regulating the entrance of the water from the conducting-pipe. When the water is shut off this valve is kept closed by a spiral spring. When the crank of the hydrant is turned forward—that is, when the water is "turned on"—the plunger is forced to the bottom of the vacuum chamber, presses on the spring, opens the valve, and allows the water to discharge. When the crank is turned back the plunger is raised, releases the spiral spring, which forces the valve into its bed, and shuts off the water. The partial vacuum produced by the raising of the plunger draws the water, which is in the vertical discharge-pipe, into the vacuum chamber, which is so far below the surface as to be unaffected by frost. In course of time, and with use, the rubber packing gets worn and permits gradual leakage into the vacuum chamber of the dirty stagnant water by which this part of the hydrant is always surrounded. Outbreaks of typhoid fever having a similar origin,[2] in which the

[1] On Preventable Pollution of Hydrant-Water and its Relation to the Spread of Typhoid Fever. Maryland Med. Journal, vol. vii, p. 271.

[2] Local Causes of Insanitation in Baltimore, by John Morris, M.D. Report Md. State Board of Health, 1878.

connection between cause and effect was clearly shown, have been reported by other physicians of the same city.

Aside from the practical question of the causation of disease by polluted water, a more abstract and æsthetic idea is involved in consciously taking any impurity into the system. The instincts of man, as well as of most animals, revolt at it. These inborn instincts, which constitute the sanitary conscience, as Soyka says, demand purity of food and water, as they insist on cleanliness of the body, of clothing, and of the dwelling.

STORAGE AND PURIFICATION OF WATER.

Wherever a large supply of water is needed, unless drawn direct from a well or spring, or pumped directly from its source, arrangements for storage are necessary. Cisterns and large reservoirs are made use of for this purpose. River-water, especially, requires a period of rest in a storage reservoir in order to allow deposition of the large amount of suspended matter in it. Prolonged storage also gives opportunity for the conversion of possibly deleterious organic compounds into simple and perhaps harmless combinations. Usually, in an elaborate system of water-works, a series of reservoirs is built, in which the water is stored successively, so that before its final distribution through the street-mains it has become quite clear and pure. Filtration on a large scale is also used in connection with storage reservoirs in order to secure greater purity of the water.

In the distribution of water, care should be taken that nothing deleterious is taken up by the water in its passage through the pipes. Lead poisoning is not infrequent from drinking-water that has passed through a long reach of lead pipe, or which has been standing in a vessel lined with lead. Tanks and storage cisterns should therefore not be lined with lead, and the use of lead pipe in the supply service should be avoided as much as possible. Fortunately, most natural waters possess a considerable proportion of carbon dioxide, which forms with the lead an almost insoluble carbonate of lead. This carbonate of lead is deposited

on the inside of the pipes, and protects both the pipes against erosive action from other constituents of the water, and also prevents the contamination of the water by the lead. An excess of carbon dioxide in the water renders this deposit soluble, and may cause serious poisoning. Any water which is shown by analysis to contain over 1 milligramme of lead per 100,000 is dangerous, and should be rejected.

Owing to the possibility of defilement of the water from improper construction of hydrants, all outdoor hydrants should be discouraged as much as possible, and should be replaced by a simple tap-cock indoors. The pipes should also be laid deep enough under-ground, or otherwise protected against freezing in winter.

A number of methods, all more or less efficient, have been introduced to purify water when it needs purification before being fit for use. These methods either comprise filtration or seek to purify the water without the aid of this process. One of the methods of purification without filtration consists in exposing the water to the air in small streams. This was proposed by Lind more than a century ago, and has since been frequently revived. The water is passed through a sieve, or a perforated tin or wooden plate, so as to cause it to fall for a distance through the air in finely-divided currents. By this process sulphuretted hydrogen, offensive organic vapors, and possibly dissolved organic matters are removed. This process has been used in Russia on a large scale.

By boiling and agitation, carbonate of lime, sulphuretted hydrogen, and organic matter are removed or rendered innocuous. Vegetable germs are usually destroyed, although Tyndall has shown that some bacterial germs withstand a temperature higher than that of boiling water. Pathogenic germs are, however, all destroyed by boiling water acting upon them for ten minutes, as shown by Dr. G. M. Sternberg.[1]

As has already been mentioned,[2] alum is one of the readiest

[1] Report of Committee on Disinfectants, 1888.

[2] See page 59.

and most efficient means of removing suspended matters from water.

Permanganate of potassium is sometimes used to purify water containing considerable organic matter. The permanganate rapidly oxidizes the organic matter, and is believed to render it harmless. There is no certainty, however, that the germs of specific diseases are destroyed by the action of this salt, in the proportion in which it could be used for the purposes of water purification.

A yellow tint is given to the water by the permanganate, which is due to finely-divided peroxide of manganese. This does no harm, but is unpleasant.

Water unfitted for use by organic matter is sometimes rendered usable by infusing certain vegetable astringents in it. Thus, it is said that in certain parts of China, where the water contains large quantities of organic matter, the inhabitants drink water only in the form of tea. The tannin of the tea-leaves precipitates the suspended matters and renders the water fit for use. Mixing the water with red wine, which is astringent, has the same effect.[1]

Filtration is an efficient means of removing suspended matters. Charcoal, sand, gravel, and spongy iron are used as filtering material. A most economical filter is one made of fine, clean sand, above which layers of gravel of a gradually-increasing size are placed. The coarser particles of suspended matter are arrested before the sand, which removes most of the coloring and organic matters, is reached.

Filters easily become fouled by the matters arrested in the interstices of the filtering material, and hence require frequent renewal or cleansing. A cheap and efficient filter is made by placing a sheet of druggists' filtering-paper in a glass funnel and filtering the water through it. A new and clean sheet of paper should be used every day.

M. Chamberland has invented a filter which is said to be

[1] Champouillon, quoted in Med. and Surg. Hist. of the War, part ii med. vol., p. 613.

absolutely germ-proof, but this power is not permanent, as after a week micro-organisms pass through the filtering material. The same is true of all other filters hitherto invented.

TESTS FOR IMPURITIES IN WATER.

Accurate and reliable quantitative analyses of water can only be made by chemists of experience. Every intelligent person should, however, know how to determine the presence or absence of suspected impurities. The following methods are simple, and easily carried out:—

The color, transparency, and odor of water are determined by the unaided senses. As a standard for comparison in making the color test, pure, distilled water may be used. Two tubes of clear, white glass, 61 centimetres long, are filled with distilled water and with the specimen to be tested, and placed side by side upon a sheet of white paper. The tops of the tubes are covered with little squares of clear glass. The color is noted by comparing the tints of the water in the two tubes. The same procedure may be used to determine the transparency of the water.

While the color and turbidity show impurities, these are not necessarily prejudicial to health; on the other hand, the clearest and most sparkling water may contain so much poisonous matter as to be positively dangerous. The odor of the water is best ascertained by heating a small quantity in a narrow-necked flask to 40° to 45° C. (104° to 113° F.), and then taking a few strong whiffs at the flask. The odor may or may not indicate the presence of deleterious substances.

The chemical examination of a water for sanitary purposes, short of a complete analysis, comprises the determination of the presence or absence of suspected impurities; in other words, it may be termed a qualitative analysis. In some cases an approximate quantitative examination may also be made with little more trouble and skill.

The examination may be divided into the following procedures:—

1. The determination of the total residue.
2. The determination of the presence of—
   (*a*) Organic matter.
   (*b*) Chlorides.
   (*c*) Nitrogen compounds.
   (*d*) Mineral poisons.

Determination of Total Solids.—Examination of the public water-supply of eight large cities in the United States shows that the total solid residue varies from 6 to 16 parts in 100,000. The total solids of a good drinking-water should not exceed 25 to 30 parts per 100,000, although a larger quantity may be present without being harmful. The method of determining the total solids is to evaporate a definite quantity—say, 70 cubic centimetres of the water—in a previously-weighed platinum dish to dryness over a water-bath. The dish is then wiped dry and weighed again. The difference in weight between the empty dish and the latter with the dry residue represents the proportion of the latter in grains per gallon. To convert this figure into parts per 100,000 the number of grains per gallon is divided by .7. For example, if the number of grains of solid residue in the specimen examined is 22.4, then

$$22.4 \div .7 = 32 \text{ parts per } 100{,}000.$$

Determination of Organic Matter.—This is the most difficult test to apply in the sanitary examination of water. While it is comparatively easy to determine the presence of organic matter, its quantity and nature are exceedingly complex problems to solve.

The presence of organic impurity in water may be detected by the permanganate-of-potash test, the nitrate-of-silver test, and the incineration test. Neither of these processes is competent to differentiate noxious from inoffensive organic matter. The permanganate test, modified by Dr. DeChaumont, is the

one usually adopted. The process is as follows: To 250 cubic centimetres of the water to be examined add 5 cubic centimetres of dilute sulphuric acid (10 per cent.) in a clear, white glass flask. Then add permanganate of potassium solution (395 milligrammes to 1 litre of distilled water) until the water has taken a pink tinge. Heat the water to 140° F. (60° C.), adding permanganate solution if the color disappears. When the temperature above mentioned is reached remove the flask from the burner, and add permanganate drop by drop until a faint pink color is obtained, which remains permanent for ten minutes. Read off the number of cubic centimetres of the permanganate solution used as required for total oxidizable matter. As the solution of permanganate yields in presence of an acid 0.1 of a milligramme of oxygen for each cubic centimetre, it is evident that the number of cubic centimetres of solution decomposed has furnished an equal number of tenths of a milligramme of oxygen which has entered into other combinations.

But, inasmuch as all the oxidizable matter in the water may not be organic, the inorganic oxidizable matter (nitrous acid) must be separated. This is done by first boiling the water with sulphuric acid, as above (250 cubic centimetres + 5 cubic centimetres), for twenty minutes, to remove the nitrous acid. Then allow the acidulated water to cool down to 60 degrees and add the permanganate until a pink color is obtained for ten minutes. The amount of permanganate solution used gives the number of milligrammes of oxygen required for oxidizable organic matter.

Determination of Chlorides.—Chlorine, or its compounds, when present in drinking-water, represent generally sewage pollution. It is true that chlorine may be in excess in water, and the latter, nevertheless, be entirely free from sewage or urine, but this occurs only where there is a natural deposit of chlorine compounds in the soil from which the supply is drawn. If communication with the sea or salt-deposits is excluded, the chlorine may be assumed to be due to the inflow of sewage.

Especially is this the case if the test for organic matter has given positive results. The proportion of chlorine may be estimated thus: Place 70 cubic centimetres of the water into an evaporating dish, and add a small fragment of neutral chromate of potash. Then, by means of a pipette graduated to tenths of a cubic centimetre, standard solution of nitrate of silver[1] should be allowed to drop into the water until the red color produced remains permanent. The number of cubic centimetres of the silver solution required to produce the permanent red tint is equivalent to the number of grains of chlorine per gallon, which, if divided by .7, gives the parts per 100,000.

Another method of determining the presence of chlorine or chlorides is as follows: Acidulate about 16 cubic centimetres of the water to be tested with pure nitric acid, and add a few drops of a solution of nitrate of silver (1.5 grammes to 32 cubic centimetres of distilled water). A white precipitate, gradually changing to gray, is produced if chlorides are present. The degree of cloudiness produced will indicate approximately the amount of chlorides: "1.5 parts of chlorine per 100,000 give a haze; 5.7 parts per 100,000 give a marked turbidity; 14 parts per 100,000, considerable precipitate." If the chlorine is found by this test to exceed 1.5 parts per 100,000, the source of the contamination should be searched for. If drainage from a cesspool is suspected, a quantity of salt water may be thrown into it, and the water again tested after an interval of four hours to see whether the chlorine has increased.

Determination of Nitrites and Nitrates.—The presence of these nitrogen compounds in drinking-water should excite suspicion of sewage contamination. They are the resultants of oxidation of nitrogenous organic matter, and, although water containing them is not necessarily dangerous, their presence should render a thorough examination of the source of supply imperative.

[1] *Standard Solution of Nitrate of Silver.*—Dissolve 4.79 grammes of crystallized nitrate of silver in 1 litre of distilled water. One cubic centimetre of this solution precipitates 1 milligramme of chlorine.

The readiest method of detecting nitrates and nitrites in water is by the pyrogallol test. This may be performed as follows: Put 2 cubic centimetres of pure sulphuric acid in a small test-tube and add 1 cubic centimetre of the water to be tested. To this mixture is added 1 drop of a solution of pyrogallol (65 centigrammes to 30 cubic centimetres) in distilled water, acidulated with 2 drops of sulphuric acid. The water becomes colored a dark amethyst or wine brown if the salts are present. The depth of color indicates approximately the amount of the impurity.

The following test for nitric acid or nitrates may also be used: A small quantity of the water is evaporated to dryness, and a few drops of a solution of carbolic acid in 4 parts of concentrated sulphuric acid and 2 parts of distilled water added to the residue. If nitric acid is present, a brownish-red color results, which turns green and then yellow upon the addition of ammonia.

Nitrous acid or nitrites will give a reaction with iodide of potassium and starch; 350 to 600 cubic centimetres of water in a flask are acidulated with a few drops of dilute sulphuric acid, and a little solution of iodide of potassium added. About 2 grammes of freshly-prepared starch are added and the mixture shaken. If nitrous acid is present, the iodide is decomposed, setting free the iodine, which combines with the starch, causing a blue color. The test is a very delicate one.

Ammonia.—The presence of this is determined by Nessler's reagent,[1] as follows: 100 cubic centimetres of the water to be examined is treated with 0.5 cubic centimetre of caustic soda solution and 1 cubic centimetre of carbonate of soda solution to precipitate the earthy salts. After the precipitate has subsided, 1 cubic centimetre of Nessler's reagent is added. If ammonia is present the water takes a yellowish tint.

[1] *Nessler's Reagent.*—Dissolve by heating and stirring 35 grammes of potassium iodide and 13 grammes of mercuric chloride in 800 cubic centimetres of distilled water. Add gradually a cold aqueous saturated solution of mercuric chloride until the red color produced just begins to be permanent; 160 grammes of solid caustic potash are then added to the mixture which is to be diluted with distilled water until it exactly measures one litre.

Determination of Mineral Poisons.—Of these the most important are lead, copper, zinc, and arsenic. The presence of any of these in even the smallest quantity is dangerous, and, if constant, the water so contaminated should not be used for drinking purposes.

In order to detect lead 250 cubic centimetres of the water is first treated with hydrochloric acid, and then sulphuretted hydrogen (in aqueous solution) is added. If a brownish or black precipitate results, either lead or copper may be present.

On filtering the water, dissolving the residue in hot, diluted nitric acid, and adding a solution of potassium bichromate, a yellow precipitate, soluble in caustic potash, is thrown down if lead is present. If the precipitate produced by sulphuretted hydrogen is dissolved, as above, and ammonia added, a blue color is produced in the presence of copper. To detect zinc the sulphuretted hydrogen precipitate is treated with caustic soda, again filtered, and sulphuretted hydrogen added to the filtering liquid. A white precipitate indicates the presence of zinc.

Arsenic is detected by Marsh's test. Mr. A. J. Cooper has prepared the following table showing the accuracy of certain tests employed for the determination of poisonous metals in drinking-water:—

TABLE V.

Metal.	Reagent.	Depth of Liquid, 3¾ Inches.	Depth of Liquid, 14½ Inches (cylinder inclosed in opaque tube).
		1 part of metal detected in	1 part of metal detected in
Copper . . .	K_4Cy_6Fe	4,000,000 of water.	11,750,000 of water.
Copper . . .	NH_4HO	1,000,000 " "	1,950,000 " "
Copper . . .	H_2S	4,150,000 " "	15,660,000 " "
Zinc	NH_4HS	2,500,000 " "	
Arsenic . . .	H_2S	3,600,000 " "	7,520,000 " "
Lead	K_2CrO_4	4,000,000 " "	5,875,000 " "
Lead	H_2S	100,000,000 " "	196,000,000 " "

In making the tests a tall glass is used, and the formation of the precipitate observed by looking down perpendicularly through the column of liquid of 3¾ inches (95 millimetres) and 14½ inches (368 millimetres) respectively.

SIGNIFICATION OF THE VARIOUS IMPURITIES INDICATED BY THE FOREGOING TESTS.

The following summary gives, briefly, the inferences that may be drawn from the result of the foregoing tests[1]:—

"If chlorine be present in considerable quantity it either comes from strata containing chloride of sodium or calcium, from impregnation of sea-water, or from admixture of liquid excreta of men and animals. In the first case the water is often alkaline from sodium carbonate; there is an absence, or nearly so, of oxidized organic matters, as indicated by nitric and nitrous acids and ammonia, and of organic matter; there is often much sulphuric acid. If it be from calcium chloride there is a large precipitate with ammonium oxalate after boiling. If the chlorine be from impregnation with sea-water, it is often in very large quantity; there is much magnesia, and little evidence of oxidized products from organic matters. If from sewage the chlorine is marked, and there is coincident evidence of nitric and nitrous acids and ammonia, and if the contamination be recent of oxidizable organic matters.

"Ammonia is almost always present in very small quantity, but if it be in large enough amount to be detected without distillation it is suspicious. If nitrates, etc., be also present, it is likely to be from animal substances, excreta, etc. Nitrates and nitrites indicate previously-existing organic matters, probably animal, but nitrates may also arise from vegetable matter, although this is probably less usual. If nitrites largely exist it is generally supposed that the contamination is recent; the coincidence of easily-oxidized organic matters, of ammonia, and of chlorine in some quantity, would be in favor of an animal origin. If a water gives the test of nitric acid, but not of nitrous acid, and very little ammonia, either potassium, sodium, or calcium nitrate is present, derived from soil impregnated with animal substances at some anterior date. If nitrites are

[1] Parkes' Hygiene, vol. i, p. 79.

present at first, and after a few days disappear, this arises from continued oxidation into nitrates; if nitrates disappear it seems probable this is caused by the action of bacteria or other low forms of life. Sometimes in such a case nitrites may be formed from the nitrates. Lime in large quantity indicates calcium carbonate if boiling removes the lime, sulphate or chloride or nitrate if boiling has little effect. Testing for calcium carbonate is important in connection with purification with alum. Sulphuric acid in large quantity, with little lime, indicate sulphate of sodium, and usually much chloride and carbonate of sodium are also present, and on evaporation the water is alkaline. Large evidence of nitric acid, with little evidence of organic matter, indicates old contamination; if the organic matter be large, and especially if there be nitrous acid as well as nitric present, the impregnation is recent."

THE BIOLOGICAL OR BACTERIOLOGICAL EXAMINATION OF DRINKING-WATER.

Since the development of the methods of cultivation of micro-organisms by Koch and his pupils, and their employment for the study of water pollution by Meade Bolton, Wolffhügel and Riedel, Percy Frankland, Prudden, and others, and the unsatisfactory results of chemical analysis, some sanitarians have expressed the conviction that the biological method is the only exact one for determining water pollution from a sanitary point of view. While this may be conceded, it is also true that very few health officers are competent to give an expert opinion upon the nature of the organisms which may be found in the water examined. It requires but little technical skill to make cultivations of bacteria from samples of water, but only an expert bacteriologist may safely pronounce upon the nature of the organisms constituting the various colonies which develop upon the nutritive gelatin. Just as the mere presence of organic matter as determined by the chemist is not indicative of a dangerous quality in the water unless the kind of organic matter

and its derivation be also specified, so likewise the presence of bacteria alone is of small significance; the danger consists not in bacteria, but in certain kinds of bacteria. The differential diagnosis is possible only to the trained bacteriologist.

While, as stated, a positive decision as to the sanitary value of a water may often be impossible, there are certain chemical and microscopical features which stamp a water as good or bad. Dr. DeChaumont gives an approximate valuation which may often serve as a useful guide.[1]

He classifies water under the four heads of Pure and Wholesome Water, Usable Water, Suspicious Water, and Impure Water. The characters of these waters are arranged in a series of tables, the essential details of which are given in Table VI.

TABLE VI.

CHEMICAL CONSTITUENTS.	PURE WATER.	USABLE WATER.	SUSPICIOUS WATER.	IMPURE WATER.
	I. Parts in 100,000.	II. Parts in 100,000.	III. Parts in 100,000.	IV. Parts in 100,000.
Chlorine in solution .	Under 1.4000	Under 4.2857	4–7	Above 7.1428
Solids " total ..	" 7.1428	" 42.8571	43–71	" 71.4285
" " volatile	" 1.4000	" 4.2857	4–7	" 7.1428
Ammonia, free or saline	" 0.0020	" 0.0050	0.0050–0.0100	" 0.0100
Ammonia, albuminoid	" 0.0050	" 0.0100	0.0100–0.0125	" 0.0125
Nitric acid in nitrates	" 0.0323	" 0.5000	0.5–1.0	" 1 0000
" " nitrites	Nil.	Nil.	0.0500	" 0.0500
Nitrogen in nitrates .	" 0.0140	" 0.1129	0.1243–0.2373	" 0 2415
Total nitrogen . . .	" 0.0230	" 0.1252	0.1255–0.2465	" 0.2601
Oxygen absorbed by permanganate and acid within half an hour at 140° F. . .	" 0.0250	" 0.1000	0.1000–0.1500	" 0.1500
Total hardness . . .	" 8.5	" 17.3	Above 17.0	" 28.5
Permanent hardness .	" 3.0	" 5.7	" 5.7	" 8.7
Phosphoric acid in phosphates . . .	Traces.	Traces.	Heavy traces.	Heavy traces.
Sulphuric acid in sulphates	"	Under 3.000	Above 3.000	Above 4.2857
Heavy metals . . .	Nil.	Traces.	Traces.	{ Any except iron.
Hydrogen sulphide .	"	Nil.	Nil.	Present.
Alkaline sulphides .	"	"	"	"

[1] Parkes' Hygiene, vol. i, pp. 103–106.

Physical Characters.	Microscopical Characters.
No. I. Colorless, or bluish tint; transparent, sparkling, and well aërated; no sediment visible to naked eye; no smell; taste palatable.	No. I. Mineral matter; vegetable forms with endochrome; large animal forms; no organic *débris*.
No. II. Colorless, or slightly greenish tint; transparent, sparkling, and well aërated; no suspended matter, or else easily separated by coarse filtration or subsidence; no smell; taste palatable.	No. II. Same as No. I.
No. III. Yellow, or strong, green color; turbid; suspended matter considerable; no smell, but any marked taste.	No. III. Vegetable and animal forms more or less pale and colorless; organic *débris;* fibres of clothing, or other evidences of house-refuse.
No. IV. Color, yellow or brown; turbid, and not easily purified by coarse filtration; large amount of suspended matter; any marked smell or taste.	No. IV. Bacteria of any kind; fungi; numerous vegetable and animal forms of low types; epithelia, or other animal structures; evidences of sewage; ova of parasites, etc.

[The following works are recommended to those desiring fuller information upon the subjects embraced in the foregoing chapter:—

Water Supply, by Wm. Ripley Nichols, N. Y., 1884.—A Guide to the Microscopic Examination of Drinking-Water, by J. D. MacDonald, R.N.F.R.S.—Sanitary Examinations of Water, Air, and Food, by Fox.—Report of the Committee on Water Pollution, Public Health, vol. xiv. Zeitschr. f. Hygiene, vol. i, by Bolton.—Prudden in N. Y. Medical Record, 1887.—Arb. aus d. Reichsgesundheitsamte, I, Wolffhügel and Riedel.]

CHAPTER III.

Food.

In order to preserve health and vigor it is necessary for animal beings to consume at intervals a sufficient quantity of substances known as foods. Alimentary substances, or foods, may, therefore, be briefly defined as materials which, taken into the body and assimilated, sustain the processes of life, promote growth, or prevent destruction of the organized constituents of the body.

QUANTITY AND CHARACTER OF FOOD NECESSARY.

It has long been known, as the result of the empirical observation of feeding large bodies of people, that the various proximate principles composing the tissues must be combined in certain definite proportions in the food in order to preserve the normal degree of health and vigor of the body. Within a comparatively recent period physiologists have made experiments upon animals and human beings which have led to the same conclusions, and have enabled these proportions to be fixed with more or less exactness.

Considering man as an omnivorous animal, it may be laid down as an invariable rule that the following four alimentary principles are necessary to his existence.[1] Neither of these principles can be dispensed with for a prolonged period without illness or death resulting.

1. *Water.*—This must be supplied in sufficient quantity to permit the interchange of tissue to be carried on in the body.

2. *Salts.*—Inorganic compounds of various kinds are

[1] Physiologie, Landois, 2te Aufl., p. 448.

necessary to the preservation and proper construction of the tissues. They are all found in sufficient quantities in the various alimentary substances consumed by man and the lower animals. A deficiency of inorganic constituents in the food is followed by disease.

3. *Proteids.*—Organic nitrogenous material, either animal or vegetable, is a necessary constituent of the food of man. Continued existence is impossible without a sufficient supply of nitrogenous substances.

4. *Fats or Carbohydrates.*—The organic non-nitrogenous or carbonaceous principles of food are also necessary to the continuance of health. They are supplied either by fats or by carbohydrates (sugar, starch, etc.), which may, within certain limits, be used as substitutes for each other. Voit has shown that 17 parts by weight, of starch, is equivalent as carbonaceous or oxidizable food to 10 parts of fat.

The physiology of nutrition has been very carefully studied by a large number of experimental physiologists, who have arrived at conclusions differing widely from those generally accepted twenty-five years ago. The division of foods into plastic and respiratory foods, or, in a general way, into proteids or muscle-builders, and fats and carbohydrates, or oxidizing foods, is now no longer recognized in science. It has been established that proteid tissues are not alone the result of proteid food, and that the accumulation of fat in the body is not altogether due to the excessive consumption of fats and carbohydrates. It has been further shown, contrary to the general belief, that the nitrogenous or proteid tissues are not used up during hard labor any faster than when at perfect rest, but that, on the contrary, increased muscular exertion is attended by increased consumption of stored-up fat.

These facts have led to a modification of the standard dietaries formerly employed. At present the standards of the quantity of food principles required to maintain equality between bodily income and expenditure are those calculated by Professor

Voit, after many experiments upon human beings and the lower animals. These standards are as follow:—

TABLE VII.

ADULT MALE OF AVERAGE WEIGHT.

	At Rest.	Moderate Labor.	Severe Labor.
Proteids	110 grammes	118 grammes	145 grammes
Fats	50 "	50 "	100 "
Carbohydrates . .	450 "	500 "	500 "

As the average weight of women is less than that of men, a reduction of from 15 to 20 per cent. in the various food principles may be made for the female ration.

The relative proportion of nitrogenous to non-nitrogenous principles in this ration is about 1 to 5. In the older diet standards, *e.g.*, Moleschott's, the proportion of nitrogenous to non-nitrogenous principles is much larger, being, for a man at moderate labor, proteids, 130 grammes; fats, 84 grammes; and carbohydrates, 404 grammes, or about 1 to 3.75.

While from ignorance, or motives of economy, many men sustain life and preserve health at hard labor on rations varying considerably from the standard above given, it is probable that, all things being considered, the most perfect physiological ration would also be the most economical. Thus, Professor Vaughan proposes a daily ration consisting of bread, cod-fish, lard, potatoes, bacon, beans, milk, sugar, and tea in such proportions as to furnish 123 grammes proteids, 70 grammes fats, and 550 grammes carbo-hydrates. The total cost or money value of this ration at present prices is about thirteen cents. In actual food value it is not inferior to the daily fare of the *habitué* of Delmonico's.

The above standard diet-tables give the relative proportions of food principles in terms of their proximate chemical composition. In practice it is very necessary to choose such food materials as will represent approximately the proximate principles

required. The following tables give the approximate value in proteids, fats, carbohydrates, and salts of a number of articles used as food:—

Table VIII.

ANIMAL FOODS.

Articles.	Water (per cent.).	Proteids[1] (per cent.).	Fats (per cent.).	Non-nitrogenous Matters (per cent.).	Ash (per cent.).	Proportion of Nitrogenous to Non-nitrogenous Matters.
Moderately fat beef	72.25	21.39	5.19	. . .	1.17	1: 0.4
Ox-heart (fat animal)	70.08	21.51	7.47	0.16	0.78	1: 0.6
Fat veal	72.31	18.88	7.41	0.07	1.33	1: 0.7
Moderately fat mutton	75.99	18.11	5.77	. . .	1.33	1: 0.6
Lean pork	72.57	19.91	6.81	. . .	1.10	1: 0.6
Salt ham	62.58	22.32	8.68	. . .	6.42	1: 0.7
Hare	74.16	23.34	1.13	0.19	1.18	1: 0 1
Venison	75 76	19.77	1.92	1.42	1.13	1: 0.2
Horse-flesh	74.27	21.71	2.55	0.46	1.01	1: 0.2
Liver-sausage	48.70	15.93	26.33	6.38	2.66	1: 3.3
Beef-extract	21.70	. . .	60 79	. . .	17.51	
Chicken (lean)	76.22	19.72	1.42	1.27	1.37	1: 0.2
Pigeon	75.10	22.14	1.00	0.76	1.00	1: 0.1
Wild duck	70.82	22.65	3.11	2.33	1.09	1: 0.3
Haddock	80.92	17.09	0.35	. . .	1.64	1: 0.0
Herring (fresh)	80.71	10.11	7.11	. . .	2.07	1: 0.0
Roach	75.49	22.23	0.47	. . .	1.71	1: 0.0
Mackerel	68.27	23.42	6.76	. . .	1.85	1: 0.5
Conger-eel	79.91	13.57	5.02	0.39	1.11	1: 0.7
Salmon	76.38	13.10	4.57	4.67	1.28	1: 1 0
Carp	76.97	20.61	1.09	. . .	1.33	1: 0 1
Pike	77.45	20.11	0.69	0.92	0.83	1: 0.1
Sole	86 14	11.94	0.25	0.45	1.22	1: 0.1
Oyster	89.69	4.95	0.37	2.62	2.37	1: 0.7
Caviar	45.05	31.90	14.14	. . .	8.91	1: 0.8
Beef-liver	72.02	19.59	5.60	1.10	1.69	1: 0.5
Calf's brains	74.14	(8 albumen)	13.14	. . .	1 0	
Sweet-bread	70.00	27.00	0.35	11.65	1. 0	
Fat of pork (salt)	9.15	9.72	75.75	. . .	5.38	1: 13.6
Hen's egg	73.67	12.55	12.11	0.55	1.12	1: 1.7
White of egg	85.75	12.67	0.25	. . .	0.59	1: 0.1
Yelk of egg	50.82	16.24	31.75	0.13	1.09	1: 3.4
Cow's milk	87.41	3.31	3.66	4.92	0.70	1: 3.4
Human milk	87.09	2.48	3 90	6.04	0.49	1: 5.2
Cream	66.41	3.70	25.72	3.54	0.63	1: 13.1
Rich cheese	35.75	27.16	30.43	2.53	4.13	1: 2.1
Lean cheese	48.02	32.65	8.41	6.80	4.12	1: 0.7
Butter	14.14	0.86	83.11	0.70	1.19	1: 169.9
Whey	93.31	0.82	0.24	4.98	0.65	1: 6.6
Kumys	87.88	2.83	0.94	7.08	1.07	1: 3.1
Condensed milk	30.34	16.07	12.10	38.88[2]	2.61	1: 3 7

[1] Containing 16 per cent. nitrogen.

[2] Containing 22.26 per cent. cane-sugar.

Table IX.

VEGETABLE FOODS.

Articles.	Water (per cent.).	Proteids (per cent.).	Fats (per cent.).	Sugar (per cent.).	Other Non-nitrogenous Matters (per cent.).	Woody Fibre (per cent.).	Ash (per cent.).	Proportion of Nitrogenous to Non-nitrogenous Matters.
Wheat	13.56	12.42	1.70	1.44	66.45	2.66	1.77	1 : 5.7
Spelt	12.09	11.02	2.77	. .	66.44	5.47	2.21	1 : 6.5
Rye	15.26	11.43	1.71	0.96	66.86	2.01	1.77	1 : 6.2
Barley	13.78	11.16	2.12	. . .	65.51	4.80	2 63	1 : 6.2
Oats	12.92	11.73	6.04	2.22	53.21	10.83	3.05	1 : 5.6
Indian corn	13.88	10.05	4.76	4.59	62.19	2.84	1.69	1 : 7.5
Hulled rice	13.23	7.81	0.69	. . .	76.40	0.78	1.09	1 : 9.9
Millet	11.26	11.29	3.56	1.18	66.15	4.25	2.31	1 : 6.5
Buckwheat	11.36	10.58	2.79	. . .	55.84	16.52	2.91	1 : 5.7
Beans	14.84	23.66	1.63	. . .	49.25	7.47	3.15	1 : 2.2
Peas	14.31	22.63	1.72	. . .	53.25	5.45	2.65	1 : 2.5
Lentils	12.51	24.81	1.85	. . .	54.78	3.58	2.47	1 : 2.3
Wheat-flour	14.86	8.91	1.11	2.32	71.86	0.33	0.61	1 : 8.5
Rye-flour	14.42	10.97	1.95	3.88	65.86	1.62	1.48	1 : 6.7
Barley-flour	15.06	11.75	1.71	3.10	67.80	0.11	0.47	1 : 6.3
Buckwheat-flour	14.27	9.28	1.89	1.06	71.40	0.89	1.21	1 : 8.2
Oatmeal	10.46	15.50	6.11	2.25	61.42	2.24	2.02	1 : 4.8
Cornmeal	14.00	11.10	8.10	. . .	65.10	. . .	1.70	1 : 6.7
Starch	14.84	1.46	. .	. . .	83.31	. . .	0.39	1 : 57.1
Macaroni	13.07	9.02	0.28	. . .	76.79	. . .	0.84	1 : 8.6
Fine wheat-bread	38.51	6.82	0.77	2.37	49.97	0.38	1.18	1 : 7.9
Fresh rye-bread	44 02	6.02	0.48	2.54	45.33	0.30	1.31	1 : 8.1
English biscuit	7.45	7.18	9.28	17.02	58.08	0.16	0.83	1 : 12.7
Potatoes	75.77	1.79	0.16	. . .	20.56	0.75	0.57	1 : 11.6
Beet (red)	87.88	1.07	0.11	6.55	2.43	1.02	0.94	1 : 8.6
Sugar-beet	83.91	2.08	0.11	9.31	2.41	1.14	1.04	1 : 5.7
Mangold root	90 51	1.40	. . .	4.68	2.14	. . .	1.27	1 : 5.8
Carrot (large)	87.05	1.04	0.21	6.74	2.66	1.40	0.90	1 : 9.4
" (small)	88.32	1.04	0.21	1.60	7.17	0.95	0.71	1 : 8.8
Turnip	91.24	0.96	0.16	4.08	1.90	0.91	0.75	1 : 6.5
Radish	86.92	2.92	0.11	1.53	6.90	1.55	1.07	1 : 4.5
Horseradish	76.72	2.73	0.35	. .	15.89	2.78	1.53	1 : 6.0
Kohl-rabi	85.01	2.95	0.22	0.40	8.45	1.76	1.21	1 : 3.1
Onion	70 18	2.68	0.10	5.78	19.91	0.81	0.54	1 : 9.6
Leek	87.62	2.83	0.29	0.44	6.09	1.49	1.24	1 : 2.5
Garlic	64.66	6.76	0.06	. . .	26.31	0.77	1.44	1 : 3.9
Cucumber	95.60	1.02	0.09	0.95	1.33	0.62	0.39	1 : 2.4
Melon	95.21	1.06	0.61	0.27	1.15	1.07	0.63	1 : 2.4
Pumpkin	90.01	0.71	0.05	1.36	5.87	1.36	0.64	1 : 10.2
Tomato	92.87	1.25	0.33	2.53	1.55	0.84	0.63	1 : 3.6
Asparagus	93.32	1.98	0.28	0.40	2.34	1.14	0.54	1 : 1.6
Green peas	80.49	5.75	0.50	. . .	10.86	1.60	0.80	1 : 2.0
Snap beans	86.10	4.67	0.30	. . .	6.60	1.69	0.64	1 : 1.5
Cauliflower	90.39	2.53	0.38	1.27	3.74	0.87	0.82	1 : 2.2
Winter cabbage	80.03	3.99	0.90	1.21	10.42	1.88	1.57	1 : 3.3
Savoy cabbage	87.09	3.31	0.71	1.29	4.73	1.23	1.64	1 : 2.2
Red cabbage	85.63	4.83	0.46	. .	6.22	1.57	1.29	1 : 1.5
Spinach	90.26	3.15	0.54	0.08	3.26	0.77	1.94	1 : 1.3
Lettuce	94.33	1.41	0.31	. . .	2.19	0.73	1.03	1 : 1.9

TABLE IX (*continued*).

VEGETABLE FOODS.

ARTICLES.	Water (per cent.).	Proteids (per cent.).	Fats (per cent.).	Sugar (per cent.).	Other Non-nitrogenous Matters (per cent.).	Woody Fibre (per cent.).	Ash (per cent.).	Proportion of Nitrogenous to Non-nitrogenous Matters.
Mushrooms (fresh) . . .	91.11	2.57	0.13	1.05	3.71	0.67	0.76	1 : 19
" (dried) . . .	17.54	23.84	1.21	9.59	34.56	6.21	7.05	1 : 19
Truffle	72.80	8.91	0.62	. . .	7.54	7 92	2.21	1 : 1.0
Apples[1]	83.58	0.39	. . .	7.73	5 17	1.98	0.31	1 : 35.2
Pears	83.03	0.36	. . .	8 26	3.54	4 30	0.31	1 : 33.3
Plums	84.86	0.40	. . .	3.56	4.68	4.34	0.66	1 : 24 3
Peaches	80.03	0.65	. . .	4 48	7.17	6.06	0.69	1 : 19.3
Apricots	81.22	0 49	. . .	4 69	6.35	5.27	0.82	1 : 24 9
Cherries	80.26	0 62	. . .	10.24	1 17	6.07	0.73	1 : 19.9
Grapes	78.17	0.59	. . .	14.36	1.96	3.60	0.53	1 : 29.0
Strawberries	87.66	1.07	0.45	6.28	0.48	2.32	0.81	1 : 7 8
Raspberries	86.21	0.53	. . .	3.95	1.54	5.90	0 49	1 : 13.0
Blackberries	86.41	0.51	. . .	4.44	1.76	5 21	0.48	1 : 14.5
Mulberries	84.71	0.36	. . .	9.19	2 31	0.91	0.66	1 : 37.1
Whortleberries	78.36	0.78	. . .	5.02	0.87	12 29	1.02	1 : 9.7
Gooseberries	85.74	0.47	. . .	7.03	1.40	3 52	0.42	1 : 21.0
Currants	84.77	0.51	. . .	6.38	0 90	4.57	0.72	1 : 18.5
Dried apples	32.42	1.06	. . .	41 61	14.68	5.59	1.96	1 : 55.6
" pears	29.41	2 07	0.35	29 13	29.67	6 86	1.67	1 : 29.1
" prunes	29.83	2 55	0.53	42.65	18.85	1.43	1.39	1 : 25.5
" cherries	49.88	2.07	0 30	31.22	14.29	0.61[2]	1.63	1 : 22 2
" raisins	32.02	2.42	0.59	54.56	7.48	1.72	1.21	1 : 26 0
" figs	32.21	5.06	. . .	45.28	.	.	2.96	1 : 8.9
Sweet almonds	5.39	24.18	53 68	. . .	7.23	6.56	2.96	1 : 4.2
Walnut	4.68	16.37	62.86	. . .	7.89	6.17	2.03	1 : 7 2
Hazel-nut	3.77	15.62	66.47	. . .	9.03	3.28	1.83	1 : 8.0
Chestnuts (fresh) . . .	51.48	5 48	1.37	. . .	38.34	1.61	1.72	1 : 7.5
Peanut	6.50	28.20	46.40	. . .	15.70	. . .	3.20	1 : 2.3

In addition to maintaining a proper proportion between the various alimentary principles, it is necessary to vary the articles of food themselves, otherwise they are liable to prove nauseating. The necessity of variety in the food, in order to preserve the appetite, is familiar to every one.

By keeping the proportions of the above table in view it will be seen at once that if a man wished to live on beef alone he would be obliged to eat about 2 kilogrammes per day in order to get a sufficient amount of non-nitrogenous food. Of

[1] These green fruits all contain in addition from .2 to 2.1 per cent. of free acid.
[2] Without stones.

potatoes, in order to get enough nitrogenous food, he would have to eat daily 8 kilogrammes. No human stomach could prove equal to the task of digesting this excess of material. On the other hand, it is to be noted how perfect the combination of the various principles is in human milk. In cows' milk, which is nearest in composition to human milk, the non-nitrogenous principles are deficient. Hence, the important practical point that when ordering milk diet for a patient a small portion of carbonaceous food (bread, rice, or sugar) must be added if the standard of health shall be reached or maintained.

Climate has probably very little influence upon the amount of food required by the individual. The actual quantity of food consumed varies little between various races or in different parts of the earth. It is true, however, that a larger proportion of fat is required in cold climates. That fatty articles of food readily undergo oxidation and furnish a large amount of animal heat is proven both by observation and experiment.

The albuminoid proximate principles of the food, proteids, are represented by the nitrogenous constituents of organic tissues. These are the vitellin and albumin of eggs, albumin, fibrin, globulin, myosin, syntonin, and other nitrogenized principles of flesh and blood ; the casein of milk, the gluten, fibrin, and legumin of cereal and leguminous seeds and plants, gelatin, and chondrin.

Fat constitutes an integral component of animal tissue, and is found in abundance as a constituent of nerve-tissue, marrow, and subcutaneous connective tissue. In food it is represented especially in the fatty tissue of meat, the yelk of eggs, butter, etc.

The carbohydrates are represented especially by various products of the vegetable world, as sugar, starch, dextrin, etc.

Water and the various other inorganic proximate principles, chief among which are compounds of calcium, sodium, and potassium, are usually found in sufficient proportion in the other alimentary substances.

The food should be taken in appropriate quantities and properly prepared. A larger quantity than necessary may overtax the digestive organs and thus yield less than the required amount of nutritive material to the body.

Physical exertion increases the consumption of fatty principles. Hence, as in the cases of the athlete or prize-fighter in training, larger quantities of these principles are required to keep the nutrition of the body at the standard of health. During mental work, however, less carbohydrate material is consumed than during physical labor.

The greater consumption of carbohydrates during muscular exercise is shown by the following table, which gives the amounts of carbon dioxide and nitrogen excreted by a man at rest and during labor:—

TABLE X.

	CO_2 Excreted.	Nitrogen Excreted.
At rest	2.1 per cent.	1.1 per cent.
At work	2.6 " "	1.1 " "

In youth the processes of combustion (production of carbon dioxide) go on with greater rapidity than after adult life is reached. For this reason young persons rarely get fat, the fat-producing food being burnt up in the body by the greater metabolic activity of the young cell. Hence, fats and carbohydrates should form a larger relative proportion in the diet of the young than in that of grown persons.

Low external temperature causes a greater and more rapid consumption of fat than high external temperature. During febrile conditions, however, the destruction of stored-up fat in the body—the wasting away—is one of the most notable phenomena; hence the importance of supplying fat and fat-producing food in chronic febrile diseases.

"Der Mensch *ist* was er *isst*," said Ludwig Feuerbach.[1]

[1] Gottheit, Freiheit und Unsterblichkeit von Standpunkt der Anthropologie, p. 5.

The pungency of the epigram is somewhat lost in the translation, which is, literally, "Man *is* what he *eats*." The intimate relations of mental, moral, and physical conditions of health to the quality and quantity of food deserve the earnest attention of the educated physician and sanitarian.

CLASSIFICATION OF FOODS.

Foods and victuals are generally divided into foods proper and so-called accessory aliment. The classification is not exact, however, as the latter, which are commonly regarded as articles of luxury, may under certain circumstances become necessities, and hence should not be considered as forming a separate class.

Foods are either of animal or vegetable origin. Those derived from animal sources are milk, the flesh of animals, birds, reptiles, and fish, and the eggs of the three last named.

The foods derived from the vegetable kingdom comprise the seeds of various plants (cereals, legumes), roots, herbs, ripe fruits, the fleshy envelopes of various seeds (which may properly be classed with the fruits), and various fungi.

There are also in common use a number of beverages, *e.g.*, water, alcoholic liquors, alkaloidal infusions (tea, coffee, cocoa), etc.

In addition, a number of substances or compounds are in common use as condiments. Their function is either to render victuals more palatable, or to promote digestion and assimilation. Vinegar, mustard, and common salt are familiar examples.

FOODS OF ANIMAL ORIGIN.

Milk.—Human milk is, so far as known, the one perfect food for man found in nature. It contains, in proper proportion, representatives of all the different classes of proximate principles necessary to nutrition. One hundred parts contain about 2.5 parts of proteids (casein and albumin); 3.9 parts of fat (butter); 6.0 parts of sugar, and .5 of salts. The reaction of human milk is slightly alkaline; that of fresh cows' milk is neutral.

In human milk there are 12.9 parts of solid matter to 87.1 of water, while in cows' milk the proportions are: Proteids, 4.0 per cent.; fats, 3.4 per cent.; sugar, 3.8 per cent.; salts, 0.6 per cent., or 11.8 total solids and 88.2 water.[1]

Of the solids in milk, cows' milk contains more proteids, while human milk is richer in fats and sugar. Hence, in using cows' milk as a substitute for human milk the proteids are diluted by the addition of water, and the non-nitrogenous components increased by adding sugar and, under some circumstances, fat (cream).

Goats' and asses' milk are sometimes used as substitutes for human milk, but they do not approach much nearer in composition to the latter than does cows' milk.

On standing, the fatty constituent of milk, the cream, separates, and on account of its less specific gravity rises to the surface, where it forms a layer of varying thickness.

After standing a longer interval the milk undergoes certain physical and chemical changes. Lactic acid is formed at the expense of part of the sugar of milk (a sort of fermentation taking place), and, acting upon the casein, produces coagulation. This is the so-called "bonny-clabber." When the fermentation continues, especially under a slightly elevated temperature, the solid portion becomes condensed (curd), and a sweetish-acid, amber-colored liquid, the whey, separates. The curd, after further fermentation, under appropriate treatment, becomes converted into cheese.

Whey is sometimes used alone or mixed with wine as an article of diet for the sick.

Butter is made from the cream by prolonged agitation in a churn. The fat-globules adhere to each other and form a soft, unctuous mass, of a yellowish color, solid at ordinary temperatures. After the butter is all removed in this way the balance of the cream remains in the churn as buttermilk. This is an article of considerable nutritive value, although its excess

[1] Average of a number of analyses.

of acid renders it unsuitable as an article of diet in many cases.

The specific gravity of fresh milk should not be below 1030. It should, however, be borne in mind that the richest milk is not always that which has the highest specific gravity. In fact, a sample of rich milk, containing a large proportion of cream, may show, when tested with the lactometer, a lower specific gravity than a specimen of much poorer milk. Hence, the lactometer, although a useful instrument in guarding against excessive dilution of the milk with water, is not a very trustworthy guide in determining the quality of the milk.

Objections are often urged against the use of so-called "skim-milk," *i.e.*, milk from which the cream has been removed. In some cities in this country the police, or representatives of the sanitary authorities, seize and confiscate all skim-milk found in possession of dealers. There appears to be no rational basis for the opinion held by many that skim-milk is not a proper and useful article of food. Before the lactic-acid fermentation has taken place it differs from fresh milk merely in the fatty and other matters removed in the cream. It contains nearly all of the proteids, sugar, and salts of whole milk, and may be used as an article of food with great advantage and entire safety. In certain diseased states it is of exceptional value as an article of diet. The sole objection of any weight to skim-milk is that it may be at times sold fraudulently as fresh milk. This is, however, a question of little sanitary interest, but one principally of commercial ethics.

Milk is frequently adulterated by the addition of water. More deleterious substances are rarely found. An excess of water gives the milk a bluish tinge and reduces its specific gravity. The addition of water may become especially dangerous by introducing the virus of some of the acute infectious diseases. Thus, the localized epidemics of typhoid and scarlet fevers have, in quite a number of instances, been traced to mixing the milk with water containing the poison of these diseases. It should,

however, be stated that milk which contains the virus of typhoid fever has not necessarily been adulterated by the addition of water. The poison may have been introduced with the water used in washing the can, and adhered to the sides of the latter. In filling the can with milk a good culture medium is supplied in which the typhoid bacillus flourishes.

It has long been a mooted question whether acute or chronic infectious diseases of the milk-giving animal may be communicated to persons using the milk of such animals. While there is little positive knowledge upon the subject, it would seem prudent to avoid the use of milk from diseased animals, if possible, or to destroy any organic virus the milk may contain by previously boiling the milk. After thorough boiling little fear need be entertained of communicating either acute or chronic infectious diseases through this medium. Demme and Uffelmann have reported cases which seem to demonstrate the possibility of tuberculous infection through the medium of the milk. Professor Bang, of Copenhagen, has recently made a series of experiments and observations which has led him to the conclusion that the milk of tuberculous cows and tuberculous women, in which there are no lesions in the mammary gland, only exceptionally contains the contagium. Professor Bang at the same time, however, points out that the milk from tuberculous udders is extremely dangerous, and that the tubercle bacilli are to be found not only in the milk itself, but in the cream, buttermilk, and butter made from it; and that such milk is sometimes infective by ingestion, even after exposure to 65° C. of heat, and by injection into the peritoneal cavity after exposure to 80° C.

The infectiousness of the milk of cows suffering from splenic fever (milzbrand, anthrax) has been proven by Bollinger and Feser. Anthrax bacilli have been found in such milk by Chambrelent and Moussons.

The agency of milk in the spread of scarlet fever is well recognized, but the manner in which the contagium gained

access to the milk was not well understood. Recently, however, an incident happened in England which seems to prove a close connection between this widespread and fatal disease and a disorder in the milk cattle. The evidence in support of this view is as follows: Mr. W. H. Power, of the English Local Government Board, was detailed to investigate certain outbreaks of scarlet fever which seemed to have especial relation to the milk-supply from a particular dairy-farm. Upon inspection this dairy was found to be in excellent sanitary condition as regards cleanliness, water-supply, sewerage, etc., and for a time considerable difficulty was experienced in locating the cause of the outbreaks. Improbable as it may at first sight appear, it seems to have been incontestably established that the epidemics of scarlatina were due to the use of milk obtained from cows attacked by a peculiar disease manifested by a vesicular eruption followed by ulceration of the udder. The chain of circumstances connecting the disease in the cows with the outbreaks of scarlet fever in certain districts in London, supplied with milk from the diseased cows, was so strongly forged by the able investigator, into whose hands the work had been committed by the authorities, that hardly a doubt can exist that the one disease owed its origin to the other.

The pathological evidence furnished by Dr. Klein lends strong support to the view that the Hendon cow disease and scarlet fever are intimately related to each other. A bacterial organism was found in the material from the ulcerated udders of the sick cows, which presents similar characters to a micrococcus found by the same observer in the blood of scarlet-fever patients. These results require more extended investigations before they can be unreservedly accepted.

The milk of cows fed upon the refuse of breweries and distilleries—"swill-milk"—is believed by many physicians to be unwholesome. If so, it is, probably, only by reason of the unfavorable hygienic conditions under which the animals are kept. If the stables are clean, dry, and well ventilated, and the animals receive plenty of fresh air and exercise, swill-fed cows

should produce as nutritious milk as when they are fed upon different food. Much of the present agitation against "swill-milk" is more prompted by political demagogism than by scientific knowledge.

The milk of animals suffering from certain diseases is often dangerous to health. In some of the Western and Southern United States, cows are not infrequently attacked by an acute febrile disease called "the trembles," from one of the prominent symptoms. The milk of cows suffering from this disease produces severe gastro-intestinal disorder, collapse, fever, etc., in the consumer. This disease, called "milk-sickness," is fatal in a pretty large proportion of cases. It is said that the flesh of animals with "the trembles" will, if eaten, produce similar dangerous effects. A late writer (Dr. Beach, of Ohio) estimates that 25 per cent. of the Western pioneers and their families died of this disease.

For the ready determination of the quality of milk, instruments known as lactoscopes, lactometers, and creamometers are used. The lactoscope indicates the opacity of the milk, upon which the proportion of cream depends. One convenient modification of the lactoscope is the little instrument termed the pioscope. This consists of a disk about 6½ centimetres in diameter, with a slight depression in the centre. A little milk is placed in the depression and covered with a glass disk, clear in the centre and opaque around the border, which is divided into six divisions of different shades, varying from white to dark gray. The quality of the milk is marked upon the division whose color corresponds with that of the milk in the centre.

A better, but still not very accurate, indicator of the quality of the milk is the creamometer. This consists of a cylindrical glass vessel with the upper half divided up into hundredths. The glass is filled up to the zero mark with milk, and allowed to stand until all the cream has separated. The thickness of this layer is then read off on the scale. In Chevallier's instru-

ment, 10 per cent. of cream is the minimum proportion that should be furnished by the milk.

The specific gravity, which is a fair guide to the quality of the milk, with the reservations above mentioned, is measured by means of the lactometer or lactodensimeter. The specific gravity of good cows' milk should not be less than 1029.

In order to prevent the rapid fermentation of milk various methods of preservation have been adopted. The addition of alkalies, or antiseptics, retards the lactic-acid fermentation, while the abstraction of a portion of the water and addition of sugar (condensed milk) preserves it for an indefinite time. The mere addition of water restores it to nearly its original condition.

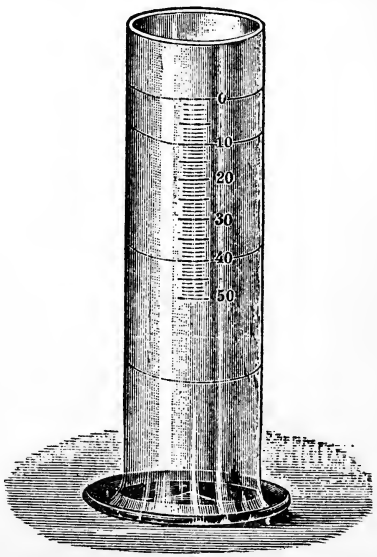

FIG. 3.—CHEVALLIER'S CREAMOMETER.

Tyrotoxicon in Milk.—This substance, first found in poisonous cheese, and later in milk, ice-cream, custards, etc., is believed by Professor Vaughan to be the cause of true cholera infantum, and many of the clinical phenomena of this disease lend strong support to such a view. The conditions under which the poison is developed have not yet been sufficiently studied to enable correct conclusions to be drawn.

Butter.—Butter is of especial value as food on account of the large amount of easily digestible fat which it contains. It is almost always used as accessory to other articles of food, to render them more palatable. When pure and fresh, it is one of the most delicious of creature comforts. It soon undergoes the butyric-acid fermentation, however, becoming "rancid," as it is termed, when it is unfit for food.

The great demand for butter and its consequent high price

have led to its extensive sophistication. Butter is now very largely substituted by an artificial product termed oleo-margarine, or butterine. This artificial butter is made from beef-suet by the following process: Fresh beef-fat is melted at as low a temperature as possible, never higher than 52° to 53° C. [126° to 128° F.]. All membrane and tissue are then removed, and the resulting clear fat is put into presses, where the stearine is extracted. The liquid fat, free from tissue, and with nearly all its stearine removed, is known as "oleo-margarine oil." The next step in the process is "churning." The oil is allowed to run into churns containing milk and a small quantity of coloring material (annatto), where, by means of rapidly-revolving paddles, it is churned for about an hour. When this part of the process is complete, the substance is drawn off from the bottom of the churn into cracked ice. When cool it is taken from the ice, mixed with a proper quantity of salt, and is then worked like butter and put into firkins for the market. It is also molded into attractive prints in imitation of dairy-butter.[1] When the materials from which oleo-margarine is made are sweet and clean, and when the process of manufacture is properly conducted, the resulting product is an entirely harmless article, and probably differs very little in nutritive value from butter itself.

Cheese.—The value of cheese as a food depends upon the large amount of proteids and fat which it contains. The rich varieties of cheese, such as Fromage de Brie and Roquefort, contain on an average 30 per cent. of fat and 27 per cent. of proteid compounds. Parmesan contains only about 8 per cent. of fat and nearly 33 per cent. of proteids, while Edam and Chester cheese, which may be considered as standing about midway between the above, contain 20 per cent. of fat and nearly 28 per cent. of proteids. From these figures it appears that cheese is one of the most nutritious aliments obtainable, but it cannot

[1] Dr. W. K. Newton, Fifth Annual Report of the State Board of Health of New Jersey, 1881, p. 107.

be eaten in large quantities at a time, as it is exceedingly liable to cause disturbances of the digestive organs. The constipating property of cheese is well known to the public.

The relative value of different kinds of cheese in alimentary principles is given in the following table:—

TABLE XI.

KIND OF CHEESE.	Proteids (per cent.).	Fats (per cent.).	Sugar (per cent.).	Salts (per cent.).
Cheshire	27.68	27.46	5.89	5.01
Edam	24.07	30.26	4.48	4.91
Holland	29.48	26.71	2.27	4.62
Roquefort	27.69	33.44	3.15	5.35
Neufchâtel	17.44	40.80	5.21	2.05
Parmesan	41.19	19.52	1.18	6.31

Cheese is not often adulterated. The only articles used with success in its sophistication are lard and oleo-margarine, which are incorporated with the casein during the process of manufacture. It sometimes undergoes chemical changes which render it intensely poisonous when eaten.

Prof. V. C. Vaughan, of the University of Michigan, has ascertained that the substance causing the poisonous symptoms is a chemical compound termed by him tyrotoxicon. This same poison has also been found by Professor Vaughan and other chemists in ice-cream and fresh milk, which produced poisonous symptoms when consumed. The poison is supposed to be a ptomaine produced by the agency of a micro-organism, which has, however, not yet been isolated.

Meat.—The flesh of mammals, reptiles, birds, fish, and invertebrate animals is used as food by man. Falck[1] has classified the varieties of animals which furnish food to the inhabitants of Europe. There are 47 varieties of the mammalian class, 105 of birds, 7 of amphibia, 110 of fish, and 58 of invertebrates.

[1] Das Fleisch, Gemeinverstændliches Handbuch der Wissenschaftlichen und Praktischen Fleischkunde.

Meat is the most important source of proteids in the food. In the more commonly used varieties of meat the proteids and fats constitute from 25 to 50 per cent. of the entire bulk, the proportion depending largely upon the age of the animal and its bodily condition. The following table shows the influence of these two factors upon the relative proportions of the fats and proteids contained in the meat:—

TABLE XII.[1]

	Proteids (per cent.).	Fats (per cent.).
Moderately fat beef	21.39	5.19
Lean beef	20.54	1.78
Veal	10.88	7.41
Very fat mutton	14.80	36.39
Fat pork	14.54	37.34
Lean pork	19.91	6.81
Hare	23.34	1.13
Lean chicken	19.72	1.42

The flesh of animals, which is neutral in reaction immediately after death, soon becomes acid in consequence of the formation of lactic acid. The acid, acting upon the sarcolemma and the muscular fibre, renders it softer and more easily permeable by fluids when cooking, and more susceptible to the action of the gastric juice when the meat is taken into the stomach.

Certain kinds of meat—mutton and venison, for example—are often kept so long before being eaten that a considerable degree of putrefaction has taken place when they are brought upon the table. The wisdom of this practice is questionable from a hygienic point of view.

Meat is sometimes eaten raw, but it is usually first cooked. The methods of cooking in general use are boiling, frying, roasting, broiling, and baking. By either of these methods of

[1] Abridged from Loebisch; article "Fleisch" in Realencyclopædie d. ges. Heilkunde, vol. v, p. 340. Fuller details will be found in Table VIII.

cooking, when properly carried out, the nutritious properties of the meat are preserved, and it is rendered digestible. The culinary art deserves the closest attention of students of hygiene.

A number of soluble preparations of meat (beef-extract, beef-essence, beef-juice) are found in the market, and highly recommended as containing all the nutritious qualities of the meat from which they are prepared. These, and similar products of domestic preparation (broths and teas), contain in reality very little nutritive material, but are of use almost solely as stimulants to the appetite and digestion. They have a place in the dietary of the sick, but their nutritive value is small.

On the other hand, a number of partly or wholly predigested (peptonized or pancreatized) preparations of meat are offered for sale, many of which have a high nutritive value. They cannot, however, be used as articles of diet except for a short time, or as a temporary succedaneum for meat in diseases attended with weakness or derangement of the digestive organs.

Meat may be unfit for food from various causes. Thus the flesh of animals dying from certain diseases—splenic fever, pleuro-pneumonia, tuberculosis in its advanced stages, cow- or sheep- pox—should not be used as food when it can be avoided. Cases are on record proving the poisonous character of meat from animals which suffered, at the time of death, from some of the above-mentioned diseases. The most important condition to be borne in mind is that certain parasites (trichina spiralis, echinococcus, cysticercus), which frequently infest the flesh of animals, especially hogs, not infrequently give rise to serious or even fatal diseases in persons consuming such meat. Any meat containing these parasites, or suspected of containing them, should therefore not be used as food unless precautions be first taken to destroy the life of the parasite.

Of the parasites mentioned the trichina spiralis is the most important in this connection, as it frequently occurs in the flesh of hogs, rats, dogs, cats, and other carnivorous animals. Rats are said to be infested with the parasite more frequently than

any other animals. The trichinæ are found in two forms, one, the mature form, inhabiting the intestinal canal. The immature form, or muscle trichinæ, are found in striped muscle, coiled into spirals and encysted in a fibrous capsule. They gain access to their host in the following manner: Flesh containing living trichinæ is taken into the stomach, where the muscular tissue and the fibrous envelope are dissolved, and the inclosed worms set free. These mature in the intestinal canal, where sexual reproduction takes place, and the young embryos pass through the intestinal walls and other tissues until they become imbedded in striated muscle. Localized epidemics of trichinosis have been reported in this country and Europe, and in nearly every instance the source of the disease has been traced to the ingestion of uncooked pork. Meat known to be trichinous should not be used unless in times of great scarcity. It may, however, be rendered innocuous by thorough cooking. A temperature of 60° to 70° (140° to 160° F.) destroys the life of the parasite and renders the meat safe. On account of the frequent occurrence of trichinæ in pork, this meat should never be eaten unless thoroughly cooked. It has been ascertained that salted and smoked pork is not free from danger, as the parasites are not killed in the process of curing the meat. Hence, ham and sausage should not be eaten raw, as the danger from these articles is almost equally as great as from fresh pork.

Cysticercus cellulosa, the transition form of one variety of tape-worm, and which is the parasite in measly pork, may also gain entrance to the human body, and, failing to undergo development, cause very serious lesions of various organs and tissues. The frequency of tape-worm is evidence that pork is often thus diseased.

The use of partially decayed meat or fish has often been the cause of serious or fatal illness. Sometimes the illness partakes of the character of septic infection. In these cases it is probable that the morbid process is due to the action of the organisms of putrefaction. In other cases the symptoms are

widely different. These cases have been the source of much perplexity to physicians and toxicologists until very recently. Within the past six years, however, Selmi, Husemann, Brouardel, Casali, and others have drawn attention to certain intensely poisonous chemical compounds found in decomposing flesh, and which have been named by Selmi *ptomaines*. While there is still much uncertainty concerning the nature of these compounds, it seems pretty well established that when flesh undergoes decomposition, in the absence of oxygen, certain unstable chemical combinations are formed which act as violent poisons. Selmi, followed by most toxicologists, believes these compounds to be alkaloids, analogous to the vegetable alkaloids, such as morphine, atropine, etc. Casali, on the other hand, disagrees with this opinion, and believes the ptomaines to be amido compounds. Husemann regards Casali's hypothesis as plausible, inasmuch as the formation of amido compounds in animal and vegetable bodies during decomposition is well established.

The form of poisoning due to the organisms of putrefaction is not infrequent. An extensive outbreak of this nature occurred at Andelfingen, in Switzerland, in 1839. A musical festival was held, at which there were over 700 present. Out of these 444 were suddenly attacked by violent gastro-enteric and nervous symptoms. Ten of the patients died. The illness was traced to roast veal, which had been kept in a warm place for two days after roasting, and which was probably in a state of partial decomposition.

The class of cases which seem more probably due to the action of ptomaines or related poisons, have been frequently observed after eating sausages or canned meats. Sausage poisoning is not rarely observed in Germany. It has been ascertained that the internal portions of the sausage are the most poisonous. It is supposed that the ptomaines, which are formed in the absence of oxygen, are the active agents in the production of the train of symptoms. Poisoning by canned meat seems to be due to a similar poison.

In July, 1885, an outbreak of disease, due to eating unwholesome beef, was caused at Momence, Illinois. Chemical examination of specimens of the meat showed the presence of an alkaloidal body, which was believed to be a ptomaine, but its nature was not definitely determined.

Fish, oysters, crabs, and lobsters frequently give rise to symptoms of poisoning. In most of these cases the poisoning is probably due to partial decomposition, but it is a well-known fact that oysters and crabs are unfit for food at certain seasons. Some persons, however, are subjects of a peculiar idiosyncrasy, in consequence of which shell-fish always produce certain unpleasant symptoms, among which nettle-rash and a choleraic attack are most prominent.

That form of fish-poisoning known among the Spaniards in the West Indies as *siguatera* is, however, very grave. The mortality is large, and in many cases death succeeds rapidly upon the attack. The symptoms are as follow: Sometimes suddenly, sometimes preceded by dizziness and indistinct vision, great prostration and paralysis occur. Often death follows the onset of the symptoms in two and three hours; exceptionally in less than twenty minutes. In most cases consciousness is totally lost; in others it persists, with interruptions, until death. Sensation and the powers of speech and deglutition fail. The jaw-muscles become paralyzed, the pulse is slowed, and the temperature diminished. There is sometimes vomiting, but no purging. The secretion of the kidneys is also checked. Dr. McSherry states[1] that he has seen all these symptoms produced by eating oysters, lobsters, and crabs unseasonably.

In Russia a form of poisoning has often been observed which results from eating salted sturgeon. In the fresh state these fish are perfectly wholesome, but when salted and eaten raw they produce a very fatal illness. The mortality is said to reach 50 per cent. of those attacked. No cases traceable to this cause have been observed in this country.

[1] Health and How to Promote it, p. 143.

It has been shown, beyond question, that the flesh of beeves suffering, when killed, from splenic fever, will produce this disease in the human subject.

In 1874 an extensive and violent outbreak of an acute disease, characterized by vomiting and purging, fever and dizziness, occurred at Middelburg, in Holland. Three hundred and forty-nine persons were attacked, of whom 6 died. The outbreak was traced to eating liver-sausage (Leberwurst), in which the characteristic bacillus of splenic fever was found on microscopic examination. In July, 1877, an outbreak of choleraic disease, from eating carbuncular meat, occurred in the town of Wurzen. In the latter epidemic the bacillus of splenic fever (*Bacillus anthracis*) was found in the intestinal canal and in the blood of those attacked.

In Detmold, in Germany, an outbreak of violent gastro-intestinal inflammation, accompanied by high fever, occurred. Among the 150 persons attacked 3 died. The disease was traced to eating the meat of a cow suffering, before death, from pleurisy (probably pleuro-pneumonia). In view of the somewhat extensive prevalence of this disease among cattle in this country at the present time, the record of this outbreak may suggest to sanitary authorities some measures for the prevention of similar epidemics on this side of the Atlantic.

In July, 1880, 72 persons who had eaten of certain beef and ham-sandwiches in Welbeck, England, were attacked by choleraic diarrhœa; 4 of the cases died. Inflammation of the lungs and small intestines were the most prominent pathological conditions found post-mortem. The smaller blood-vessels of the kidneys were filled with finger-shaped bacilli, which, when cultivated and inoculated into guinea-pigs, rats, and white mice, produced similar pathological conditions. At Nottingham, England, in 1881, a number of persons were attacked by a similar train of symptoms after eating baked pork. One case terminated fatally out of the 15 attacked. It is uncertain whether the meat in these two instances was from diseased

animals or whether it had undergone partial decomposition. The former is the more probable supposition, although the organisms found were neither those of splenic fever nor swine plague, but resembled those of symptomatic anthrax (black leg or black quarter).

Whether the flesh of tuberculous animals can communicate tuberculosis to the consumer is still an unsettled question. Foreign veterinarians and hygienists who have studied the question incline to the view that there is danger of such transmission. At the International Sanitary Congress of 1883, at Brussels, the subject was discussed, and M. Lydtin, the chief veterinary surgeon of the Grand Duchy of Baden, submitted the following propositions, which were adopted by the Congress:

1. That the flesh and viscera of tuberculous animals may be used as food, provided the disease is only commencing, the lesions extending but to a small part of the body, the lymphatic glands being still healthy; provided the tubercle centres have not undergone softening, and provided the carcass is well nourished and the flesh presents the characters of meat of the first quality. 2. That the flesh of animals showing very pronounced tuberculous infection should be saturated with petroleum, and afterward burned under the direction of the police. 3. That the milk from cows affected with pulmonary phthisis, or suspected of having it, should not be consumed by man or other animals, and the sale of it should be strictly prohibited.

The congress for the study of tuberculosis, which met in Paris in 1888, adopted resolutions of a more decided character against the use of meat and milk from tuberculous animals.

Certain animals can devour with impunity substances which are intensely poisonous to human beings. The flesh of the animals may be impregnated with these poisons, and cause serious and fatal illness in persons partaking of it. In this way may, perhaps, be explained the cases of poisoning sometimes following the eating of partridges and other birds.

The prevention of disease from tainted meat is one of the

most important problems of public hygiene. Food animals should be inspected by qualified inspectors before slaughtering, to exclude animals suffering from diseases that would vitiate the meat. When the meat is exposed for sale upon the dealer's stall it should be again inspected, and all found unfit for use as food confiscated and destroyed. Meat, in which the presence of trichinæ or other parasites is suspected, should be examined microscopically.[1]

Eggs.—Although eggs contain a large amount of the proteid and fatty alimentary principles,[2] their value as food has probably been greatly overrated. The savory taste and ready digestibility of eggs has, however, rendered them a popular article of food. For obvious reasons, the eggs of the common barn-yard fowl are most frequently used, those of ducks and geese being far inferior in flavor to the first named, and being likewise less easily obtained.

The method of cooking eggs is generally supposed to have considerable influence upon their digestibility. According to Dr. Beaumont's experiments made on Alexis St. Martin, raw eggs are digested in one and a half to two hours, fresh-roasted in two hours and fifteen minutes, soft-boiled or poached in three hours, and hard-boiled or fried in three and a half hours. These experiments are, however, of very little value as a basis for general conclusions. It is probable that a hard-boiled egg is quite as easily digested in the healthy stomach as a raw one, if care be taken to masticate it well and eat bread with it, so that it is introduced into the stomach in a finely-divided state.

Eggs readily undergo putrefaction, when sulphuretted hydrogen is formed in them in large quantities. When this has taken place they are manifestly unfit to be used as food.

[1] The prevention of the diseases of animals by National and State authorities is one of the most logical and thorough-going means of preventing disease from unwholesome meat. The American Public Health Association has for some years devoted considerable attention to the investigation of the diseases of animals and means for their prevention. The Department of the Interior of the National Government has likewise made the diseases of cattle and hogs a subject of study and published some valuable reports thereon.

[2] See analysis in Table VIII.

FOODS OF VEGETABLE ORIGIN.

Bread.—The various cereal grains, when ground into flour, are used in making bread. The flours of wheat, rye, barley, buckwheat, and Indian corn are almost exclusively used in bread-making. The bran or cortical portion of grain contains a larger percentage of proteid principles than the white internal portion; hence, flours made from the whole grain (bran-flour, Graham flour) if finely ground are more nutritious than the white flours. The latter are, however, more digestible, and hence furnish a larger proportion of nutriment, because the principles contained in white flours are absorbed and assimilated to a greater degree.

Good bread should be light, porous, and well baked. The lightness and porosity are due to carbon-dioxide gas imprisoned in cavities of the dough during the process of bread-making. By adding yeast to the dough a fermentation is caused in the latter, in consequence of which a portion of the starch is converted into sugar, and then into alcohol and carbon dioxide. During the process of mixing the dough the entire mass becomes permeated by the gas, which, on heating, expands and leaves the numerous large and small cavities throughout the loaf which indicate properly-made bread.

Instead of yeast some persons use leaven, which is simply a portion of fermenting dough, saved from previous baking. A small quantity of this added to a mass of dough starts up the fermentation in a similar manner to that of yeast.

The production of carbon dioxide by fermentation in the dough goes on at the expense of part of the starch. It has been proposed, therefore, to supply the carbon dioxide from without, thus saving the entire amount of the carbohydrates present in the flour. This is accomplished in two ways—first, by the use of some alkaline carbonate or bicarbonate (bicarbonate of sodium, carbonate of ammonium), the carbon dioxide being set free on the application of heat; or, secondly, by forcing the gas, previously prepared, into the dough by means of machinery.

Flour is not infrequently adulterated with chalk, gypsum, pipe-clay, and similar articles. These are easily detected by adding a mineral acid, which produces effervescence when it comes in contact with the alkaline carbonate used as adulterant. Potato- and bean- meals are also used as adulterants of the higher grades of flour. Bakers often mix alum with inferior grades of flour. This imparts a greater degree of whiteness to the bread, and, in addition, enables it to retain a large proportion of water, thereby increasing the weight of the loaf.

Formerly diseased grain (ergotized rye) often caused outbreaks of disease when the flour made from the diseased grain was used in bread-making. At the present time such accidents rarely occur. In some parts of Italy it is said that an endemic disease—pellagra—is caused by the consumption of diseased Indian corn. The evidence in favor of this view is, however, not unquestioned.

Potatoes and rice are often used with satisfaction as substitutes for bread. They both contain a large proportion of carbohydrates. Indian corn (hominy) and oatmeal are likewise wholesome and nutritious foods of this class.

The leguminous seeds (beans, peas, lentils) furnish a food containing a large percentage of proteids. According to the analyses of Kœnig[1] the average composition of the most frequently used legumes in the dried condition is as follows:—

TABLE XIII.

	Beans.	Peas.	Lentils.	Ground-nuts.[2]
Water, per cent. . . .	13.6	14.3	12.5	6.5
Solids, per cent. . . .	86.4	85.7	87.5	93.5
Proteids, per cent. . .	23.1	22.6	24.8	28.2
Fats	2.3	1.7	1.9	46.4
Carbohydrates, per cent.	53.6	53.2	54.7	15.7
Cellulose, per cent. . .	3.9	5.5	3.6	
Ash	3.5	2.7	2.5	3.2

[1] Die Menschlichen Nahrungs und Genussmittel, ii, p. 288.

[2] The American pea-nut, the fruit or nut of *Arachis hypogœa*.

Beans, peas, and lentils are often added to other articles of food with advantage. In recent years an important article of food for armies has been made of various legumes ground into flour and mixed with fat, dried and powdered meat, salt, and spice. This constitutes the so-called "Erbswurst," or pea-sausage, which formed such an important part of the dietary of the German army in the Franco-German war of 1871. Bean- and pea- meals are also used sometimes as additions to other flours in bread-making. The dried leguminous fruits cannot be used as regular articles of diet, however, as they soon pall upon the taste, and produce indigestion, nausea, and other intestinal derangements.

Green Vegetables.—The plants usually classed together as "vegetables," the products of the market-garden or truck-farm, comprise cabbages, turnips, parsnips, onions, beets, carrots, tomatoes, lettuce, green peas and beans, and similar articles. They all contain a large proportion of water, a variable proportion of sugar, and a small percentage of proteid principles. Much of their palatability and digestibility depend upon the methods by which they are prepared for the table. All garden vegetables should be used soon after being gathered, as they rapidly undergo decomposition, and are liable to produce derangements of the digestive organs if used under these conditions.

Fruits and nuts generally contain large quantities of sugar and fats. They form agreeable additions to other articles of diet, but are insufficient to sustain life. The use of fruits usually produces copious intestinal evacuations, and they are, therefore, especially to be recommended to persons of sedentary occupations, in whom torpidity of the bowels is so frequently present.

Condiments.—Various aromatic herbs and seeds are used as additions to other articles of food, to increase their sapidity and to promote a larger flow of saliva and gastric juice, and so assist digestion. Mustard, pepper, allspice, and vinegar are the principal condiments. Within certain limits they are not injurious, but the tendency in the use of all stimulants is to

exceed a healthful limit. Condiments, as well as other stimulants, should be used in moderation.

COOKING.

Much more attention than is generally given should be paid by physicians to the culinary art. The manner in which food is cooked has no little influence upon its digestibility. There can be no question that the extreme prevalence of functional indigestion in this country is almost exclusively dependent upon bad cooking.

The various methods of cooking are boiling, frying, roasting, broiling, and baking. By either of these methods food can be cooked so as to be palatable as well as digestible; on the other hand, the choicest article can be utterly spoiled and rendered unfit to be taken into the human stomach. It depends, therefore, not so much upon the method of cooking, as upon the knowledge and art of the cook.

Boiling.—Meats of all kinds are rendered tender and digestible by boiling. In order to retain the flavor of meat, the water should be boiling when the meat is put into it. By the heat of the boiling water the albumen on the outside of the meat is coagulated and the juices and flavor retained within. After a few minutes the temperature of the water should be reduced to 71° to 77° C. (160° to 170° F.), and maintained at that height until the meat is tender. By this process a much more savory piece of beef, mutton, or fowl can be obtained than where the meat is put into cold water and thus gradually heated. The latter method is, however, the proper one to be followed when good soup or broth is desired.

In boiling vegetables, as much care is necessary as in boiling meat or fish. Potatoes and rice should be steamed, rather than boiled.

The difficulty of obtaining a good cup of coffee, especially in the northern portion of the United States, illustrates the prevailing ignorance upon one of the simplest points in the art of

cooking. Coffee should never be served in the form of a decoction; that is to say, it should never be boiled. Properly made it is an infusion, like tea, which no one ever thinks of boiling. The difference between an infusion (especially if made by percolation) and a decoction of coffee can only be appreciated by those who have enjoyed the one and endured the other.

Frying.—Frying, if properly done, is really nothing less nor more than boiling in oil or fluid fat of some kind. Olive-oil is preferable, but is not essential; butter, beef-drippings, lard, or probably cotton-seed oil may be substituted for it without disadvantage. The principle of frying depends upon the fact that the temperature of oil can be raised to such a height as to produce instant coagulation of the surface of meat, fish, or other object immersed in it while hot; this film of coagulated albumen imprisons the juices and flavors of the meat or fish, and prevents the fat entering and soaking the fibres with grease. Small fish or birds, properly fried, are justly regarded as delicacies by connoisseurs, but the process of saturating these objects with fat while gradually heating them produces a dish that is anything rather than grateful to the palate, or conducive to good digestion.

Roasting.—The fame of "the roast beef of Old England" has passed into song, but, at the present day, beef and other meats are rarely roasted, either in this country or abroad. As Sir Henry Thompson well expresses it,[1] "the joint, which formerly turned in a current of fresh air before a well-made fire, is now half stifled in a close atmosphere of its own vapors, very much to the destruction of the characteristic flavor of a roast." It is probable that the old method of roasting before an open fire produced not only the most savory, but likewise the most nutritious and digestible, meat. It is much to be regretted that the process has fallen so greatly into disuse.

Broiling and Baking.—These methods of cooking are modifications of the process of roasting. Meats or fish, carefully broiled or baked, preserve their natural juices and flavors

[1] Food and Feeding, p. 45. London, 1880.

to a great extent, and retain their digestibility and nutritious properties. Of all methods of cooking these are probably best known and most satisfactorily applied in this country.[1]

ALIMENTARY BEVERAGES.

The alimentary beverages may be divided into two classes, —those depending for their effects upon the alcohol they contain, and those whose active principles reside in certain alkaloids. They are used chiefly as digestive and nervous stimulants.

BEVERAGES CONTAINING ALCOHOL.

The physiological action of alcohol has been pretty fully worked out by Binz and his pupils, and by other experimenters. From these researches, it appears that the first effect of taking alcohol, sufficiently diluted, into the stomach, is to increase the flow of the saliva and gastric juice. This effect is probably reflex, and results from a stimulation of nerve terminations in the stomach. The alcohol is rapidly absorbed, and is carried in the blood, without undergoing chemical change, to the nervous centres, lungs, and tissues generally. In the brain the alcohol probably enters into combination with the nervous tissue, modifying the normal activity of the various centres, either increasing the activity, if the alcohol is in small quantity (stimulating effect), or diminishing it if in larger quantity (depressing effect), or entirely suspending the activity of the centres, if in sufficiently large quantity (paralyzing effect).

Alcohol stimulates the vasodilator nerves, causing dilatation of the smaller vessels; in consequence of this the blood is largely sent to the periphery of the body; the blood-pressure diminishes, and heat-radiation is increased. At the same time a portion of the alcohol is used up in the lungs in the production of animal heat, thus economizing the expenditure of fats

[1] Every one interested in the proper application of the principles of cookery should study the Lomb prize essay of the American Public Health Association, by Mary Hinman Abel, upon "Practical, Sanitary, and Economic Cooking." This little book can be obtained of Dr. I. A. Watson, Secretary, Concord, N. H.; price, 25 cents. See, also, an essay on "The Art of Cooking," by Edward Atkinson, LL.D., in Popular Science Monthly, November, 1889.

and proteids, and acting as a true respiratory food. Alcohol does not contribute nutritive material to the body; it only permits that which is stored up to be saved for other uses, by furnishing easily-oxidizable (combustible) material for carrying on the respiratory process, and supplying animal heat.

During the use of alcohol the excretion of urea is diminished. This shows that waste of tissue is retarded in the body.

Regarding the statement of some authorities that alcohol does not undergo any change in the body, but is excreted unchanged, Binz asserts[1] that alcohol appears in the urine only when exceptionally large quantities have been taken, and then in very small proportion. It is not excreted by the lungs, the peculiar odor of the breath being due not to the alcohol, but to the volatile aromatic ether, which is oxidized with greater difficulty, and so escapes unchanged.

While alcohol produces subjectively an agreeable sensation of warmth in the stomach and on the surface of the body, the bodily temperature is not raised. The subjective sensation is due to the dilatation of the blood-vessels and the sudden hyperæmia of those parts.

During fevers and other exhausting diseases, alcohol is invaluable to prevent waste of tissue and sustain the strength. It does not act merely as a stimulant to the circulation and nervous system, but, as above pointed out, saves the more stable compounds by furnishing a readily oxidizable respiratory food.

When taken in small doses by healthy persons, alcohol diminishes the temperature by increasing heat-radiation. When large quantities are taken, the bodily temperature is reduced by diminishing heat production, as well as by increased radiation. This is shown in the condition known as dead-drunkenness, in which the temperature is sometimes depressed as much as 20° F. below the normal. Cases in which the temperature sank to 75°, 78.8°, and 83° F. have been reported, with recovery in all cases.

[1] Realencyclopædie d. ges. Heilk., Bd. I, p. 183.

The constant use of alcohol produces in all the organs an excess of connective tissue, followed by fatty degeneration and the condition known as cirrhosis. The organs most frequently affected are the stomach, liver, and kidneys. Serious pathological alterations also occur in the circulatory, respiratory, and nervous systems.

Alcohol is not necessary to persons in good health. Probably most persons, regardless of their state of health, do better without it. Its habitual use in the form of strong liquors is to be unreservedly condemned. The lighter wines and malt liquors, if obtained pure, may be consumed in moderate quantities without ill effects. Even in these forms, however, the use of alcohol should be discouraged or, perhaps, prohibited in the young.

Neither in hot nor in cold climates is alcohol necessary to the preservation of health, and its moderate use even produces more injury than benefit. The Polar voyager and the East India merchant are alike better off without alcohol than with it.

It has long been a prevalent belief that the use of alcohol enables persons to withstand fatigue better than where no alcohol is used. A large amount of concurrent testimony absolutely negatives this belief.[1]

The predisposition to many diseases is greatly increased by the habitual use of alcohol. Sun-stroke, the acute infectious diseases, and many local organic affections attack, by preference, the intemperate. A recent collective investigation by the British Medical Association brought out the fact that croupous pneumonia is vastly more fatal among the intemperate than among those who abstained from the use of alcoholic liquors.

A further investigation by Baer has shown that the average expectation of life among users and dealers in alcoholic liquors is very much shortened. The following table gives a comparative view of the expectation of life in those who abstained from and those who used alcohol:—

[1] See Parkes' Hygiene, 6th ed., vol. i, pp. 315–327.

TABLE XIV.

EXPECTATION OF LIFE.

Age.	Abstainers.	Alcohol Users.
At 25	32.08 years.	26.23 years.
" 35	25.92 "	20.01 "
" 45	19.92 "	15.19 "
" 55	14.45 "	11.16 "
" 65	9.62 "	8.04 "

Table XV shows the influence of alcohol upon the mortality from various diseases:—

TABLE XV.

	General Male Population (per cent.).	Alcohol Venders (per cent.).
Brain disease	11.77	14.43
Tuberculosis	30.36	36.57
Pneumonia and pleuritis	9.63	11.44
Heart disease	1.46	3.29
Kidney disease	1.40	2.11
Suicide	2.99	4.02
Cancer	2.49	3.70
Old age	22.49	7.05

Alcohol as a beverage is consumed in the various forms of spirits, wines, and fermented liquors. The varieties of spirits most frequently used are brandy, whisky, rum, and gin. They are all procured by distillation.

Brandy is distilled from fermented grape-juice, and has a characteristic aromatic flavor. When pure and mellowed with age it is the most grateful to the palate of all distilled spirits.

Whisky is distilled from barley, rye, oats, corn, or potatoes. Each of these has a peculiar flavor, depending upon the particular volatile ether formed during the distillation. Rye-, barley-, and corn- whiskies are almost exclusively used in this country.

Rum is distilled from molasses, and is a favorite ingredient in hot punches. It is often used with milk, eggs, and sugar, in the preparation of eggnog, a highly-nutritious, stimulating drink, which is often prescribed with great benefit in acute and chronic wasting diseases.

Gin is an ardent distilled spirit, flavored with oil of juniper. It has a widely-spread popular reputation as a cure for kidney diseases, but is probably oftener responsible for the production of these diseases than for their cure.

All of the above-mentioned liquors contain from 40 to 60 per cent. of alcohol, and should always be diluted before being taken into the stomach, in order to prevent the local irritant effects of the alcohol upon the gastric mucous membrane.

Wine is the product of the alcoholic fermentation of the saccharine constituents of fruits. Wine is usually derived from the grape, though other fruits may also furnish it. The stronger wines (sherry, port, madeira) contain from 16 to 25 per cent. of alcohol. The lighter wines (hock, red and white Bordeaux and Burgundy wines, champagnes) contain from 6 to 15 per cent. of alcohol. Some also contain considerable free carbonic acid (sparkling wines), of which the champagnes are types. The red and white Bordeaux and Rhine wines are probably the least objectionable of these beverages for habitual use. They contain sufficient alcohol to be lightly stimulant, have a pleasant acid flavor, and are least likely to produce the bad effects which usually follow in the wake of the habitual use of the stronger wines or ardent spirits.

Preference should be given to the wines of domestic manufacture, on account of the great probability of adulteration of the favorite brands of foreign wines. Many of the California, Virginia, New York, and Ohio wines compare very favorably in flavor with those imported from abroad. The more reasonable cost of these domestic wines is also a point in their favor.

Cider is the fermented juice of apples. It frequently produces unpleasant gastric and intestinal disturbances when drunk,

on account of the large quantity of malic acid contained in it. Although it is usually ranked as a "temperance drink," it is quite capable of causing intoxication when consumed in large quantities.

Beer is the fermented extract of barley, mixed with a decoction of hops and boiled. It should be prepared only of malt, hops, yeast, and water, and should contain from 3 to 4 per cent. of alcohol, 5 to 6 per cent. of extract of malt and hops, 2 to 4 per cent. of lactic and acetic acids, and from $\frac{1}{4}$ to $\frac{1}{2}$ per cent. of carbonic acid. This ideal is, however, rarely attained in the article sold by the liquor dealer. Numerous adulterations are practiced on the unsuspecting consumer. The hops are frequently substituted by aloes, calamus, and ginger, or by the more deleterious picric acid or picrotoxin. The rich brown color, sweetness, body, and creamy foam are produced by caramel and glycerin. The more expensive barley-malt is substituted by starch and rice, or grape-sugar and molasses.

Ale, porter, and brown-stout are merely varieties of beer—some containing more sugar, others more extractive matter.

Beer and its correlatives have considerable dietetic value, owing not merely to the alcohol they contain, but largely to the sugar and acids entering into their composition. When used to excess they often cause a considerable accumulation of fat.

Kumys is the national beverage of the nomadic tribes of Tartary. It consists of the milk of mares which has undergone fermentation, partly lactic and partly alcoholic in character. Recently it has been introduced into Europe and also into this country, where it is made of cows' milk. It is a palatable, nutritious stimulant, and is often very useful as a dietetic article in disease.

Kefyr is a product of the fermentation of milk which bears some resemblance to kumys. The following table (Table XVI) gives a comparative view of the composition of true kumys, the same prepared from cows' milk, and kefyr:—

TABLE XVI.

	True Kumys (per cent.).	Cows' Milk Kumys (per cent.).	Kefyr (per cent.).
Proteids	2.20	2.35	3.12
Fats	2.12	2.07	1.95
Sugar	1.53	1.81	1.62
Lactic acid	0.90	0.40	0.83
Alcohol	1.72	1.90	2.10
CO_2	0.85	0.80	0.92

THE ALKALOIDAL BEVERAGES.

The virtues of the alkaloidal beverages depend upon certain alkaloids which differ very little in their chemical composition or physiological effects, and upon certain volatile aromatic constituents of the various articles used. The principal articles employed in the preparation of these beverages are coffee, tea, chocolate, maté, and coca. It is estimated that 500,000,000 people drink coffee, 100,000,000 tea, 50,000,000 chocolate, 15,000,000 maté or Paraguay tea, and 10,000,000 coca. All of these are active nervous stimulants and retarders of tissue-waste. They are all liable to produce serious functional disturbances of the nervous, digestive, and circulatory systems if used to excess. Anæmia, digestive derangements, constipation, pale, sallow complexion, loss of appetite, disturbed sleep, nervous headaches and neuralgias are the most marked of these effects.

On the other hand, when taken in moderate quantity, the alkaloidal beverages enable the consumer to withstand cold, fatigue, and hunger; they promptly remove the sensation of hunger, and diffuse a glow of exhilaration throughout the body.

Coffee.—Coffee is the ripe fruit (seed) of the *Caffea Arabica*, a native of Arabia and Eastern Africa, but now cultivated in other tropical regions of the world. The fruit consists of two flat-convex beans, the flat surfaces of which are apposed to each other. These are enclosed in a fibrous envelope which is sometimes used as a cheap substitute for the coffee-bean.

The beverage, coffee, is an infusion of the roasted and

ground bean in hot water. Its virtues depend upon the alkaloid, caffein, and an aromatic oil. The latter, being volatile, is driven off by long-continued heat. Hence boiled coffee lacks the grateful aroma of that which is made by simply infusing the ground bean in hot water.

The great demand for coffee and its comparatively high price have caused it to be extensively adulterated and substituted by other natural and artificial products. Artificial coffee-beans have been made of clay, dough, or extract of chicory, colored to imitate the natural bean. The fraud is easily detected by placing the beans in water, when the artificial product soon falls to pieces, while the natural beans undergo no change of shape or consistence.

Ground coffee as found in the stores is usually adulterated. The materials used for sophistication are: The grounds of coffee previously used, the roasted root of chicory, acorns, rye or barley, carrots, sunflower-seeds, caramel, and a number of articles of similar value, generally harmless.

Tea.—The plants which furnish the tea-leaves are natives of China, Indo-China, and Japan. The tea-leaves contain a crystalline alkaloid, thein, identical in composition and properties with caffein. The various sorts of tea found in the market (green and black teas, etc.) differ only in the relative proportion of tannin and thein contained in each. The aromatic principle also varies somewhat in the different sorts.

Tea is adulterated to quite as great an extent as coffee, the leaves of various plants bearing more or less resemblance to tea-leaves being added to the latter. Much of the tea found in the market is colored artificially with Prussian blue and iron oxide. These additions are harmless, as they are not soluble in water.

Chocolate.—Cocoa, from which chocolate is derived, is widely different in composition from tea and coffee. In addition to its active principle, theobromin, which is identical with caffein and thein, it contains nearly 50 per cent. of fat, which renders it an article of high nutritive value.

Maté, or Paraguay tea, guarana, and coca are used to a considerable extent in some parts of South America as substitutes for coffee and tea. Their composition is not well known, but their effects are believed to depend upon alkaloidal principles similar to caffein and thein.

TOBACCO.

Closely connected with the subjects treated in this chapter are the effects of the constant use of tobacco upon the human system The depressing effects of tobacco, due principally to the nicotine upon the nervous and digestive systems, have long been recognized. Recently, however, it has been found that very serious symptoms are produced upon the sense of vision by the constant or excessive use of tobacco. A special form of amaurosis, termed tobacco amaurosis, has been frequently noticed since attention was first called to it by Mackenzie.

[The following additional works are recommended to the student:—

Thos. K. Chambers, on Diet in Health and Disease.—Edward Smith, on Foods.—Förster, Ernährung, in Pettenkofer u. Ziemssen's Handbuch der Hygiene.—Munk und Uffelmann, Die Ernährung des Gesunden und Kranken Menschen.]

CHAPTER IV.

Soil.

Hippocrates treated at length, in one of his works, of the sanitary influences of the soil. Others of the older writers, especially Herodotus and Galen, called attention to the same subject, and Vitruvius, the celebrated Roman architect, who flourished about the beginning of the Christian era, taught that a point of first importance in building a dwelling was to select a site upon a healthy soil.

From this time until the beginning of the eighteenth century, very little of value is found in medical literature bearing upon this subject. In 1717, however, Lancisi published his great work on the causes of malarial fevers, in which he laid the foundation for the modern theory of malaria, and pointed out the relations existing between marshes and low-lying lands and those diseases by common consent called malarial. Other authors of the eighteenth and the early part of the nineteenth centuries refer to the connection between the soil and disease, but exact investigations have only been made within the last thirty years.

When it is considered that the air that human beings breathe, and much of the water they drink, are influenced in their composition by the matters in the soil, the great importance of possessing a thorough knowledge of the physical and chemical conditions of the soil becomes evident to every one.

PHYSICAL AND CHEMICAL CHARACTERS OF THE SOIL.

In the hygienic, as in the geological sense, rock, sand, clay, and gravel are included in the consideration of soils.

The soil, as it is presented to us at the surface of the earth,

is the result of long ages of disintegration of the primitive rocks by the action of the elements, of the decomposition of organic remains, and, possibly, of accretions of cosmical dust. The principal factor, however, is the action of water upon rock, in leveling the projections of the earth's surface produced by volcanic action.

Soils vary considerably in physical and chemical constitution. A soil may, for example, consist exclusively of sand, of clay, or of disintegrated calcareous matter. Other soils may consist of a mixture of two or more of these, together with vegetable matter undergoing slow oxidation. In forests, a layer of this slowly-decomposing vegetable matter of varying thickness is found, covering the earthy substratum. This organic layer is called *humus*, and when turned under by plough or spade, and mixed with the sand or clay base, it constitutes the ordinary agricultural soil.

THE ATMOSPHERE OF THE SOIL, OR GROUND-AIR.

The interstices of the soil are occupied by air or water, or by both together. The soil's atmosphere is continuous with, and resembles in physical and chemical properties, that which envelops the earth. Its proportion to the mass of the soil depends upon the degree of porosity of the soil, and upon the amount of moisture present. In a very porous soil, such as, for example, a coarse sand, gravelly loam, or coarse-grained sandstone, the amount of air is much greater than in a clayey soil, granite, or marble. So, likewise, when the soil contains a large proportion of water, the air is to this extent excluded. The porosity of the various soils, as evidenced by the amount of air contained in them, is much greater than would, at first thought, be supposed. Thus it has been found that porous sandstone may contain as much as one-third of its bulk of air, while the proportion of air contained in sand, gravel, or loose soil may amount to from 30 to 50 per cent.

The ground-air is simply the atmospheric air which has

penetrated into the interstices of the soil and taken part in the various chemical decompositions going on there. In consequence of these chemical changes the relative proportions of the oxygen and carbonic acid in the air are changed—oxygen disappearing and giving place to carbon dioxide. It is well known that during the decay of vegetable matter in the air carbon dioxide is formed; one constituent of this compound, the carbon, being derived from the vegetable matter, while the oxygen is taken from the air. Hence, if this action takes place where there is not a very free circulation of air, as in the soil, the air there present soon loses its normal proportion of oxygen, which enters into combination with the carbon of the vegetable matter to form carbon dioxide.

Thirty years ago, MM. Boussingault and Lévy, two distinguished French chemists, examined the air contained in ordinary agricultural soil, and found that the oxygen was diminished to about one-half of the proportion normally present in atmospheric air, while the carbon dioxide was enormously increased. The exact results obtained by Boussingault and Lévy were as follow:—

In 100 volumes of ground-air there were 10.35 volumes of oxygen, 79.91 volumes of nitrogen, 9.74 volumes of carbon dioxide. In atmospheric air, on the other hand, there are in 100 volumes 20.9 volumes of oxygen, 79.1 volumes of nitrogen, 0.04 volume, or about $\frac{1}{2\frac{1}{5}}$ of 1 per cent. of carbon dioxide.

In spite of the striking results obtained by these two chemists, very little attention was paid to them by sanitarians, as very few seemed to have any clear notion of the relations existing between the motions of the air above-ground and that underground.

In 1871, however, Professor von Pettenkofer, of Munich, published the results of his own examinations into the constitution and physical conditions of the ground-air, and the relations of the latter to the propagation of epidemic diseases. These researches, which created a wide-spread interest in the subject,

were extended by other observers in all parts of the world. These observers, prominent among whom were Professors Fleck, Fodor, and Soyka, in Germany; Drs. Lewis and Cunningham, in India; Prof. William Ripley Nichols, in Boston; and Surgeons J. H. Kidder and S. H. Griffith, of the U. S. Navy, in Washington, demonstrated that the increase of carbon dioxide in the ground-air is due to increased vegetable decomposition and to lessened permeability of the soil. A permeable, that is to say, a sandy or gravelly soil is likely to contain less carbon dioxide in its atmosphere than a dense, less permeable clay, although the amount of decomposition going on and the production of carbon dioxide in the former may considerably exceed the latter. In the loose, sandy soil the circulation of the air is less obstructed, and the carbon dioxide may easily escape and be diffused in the superincumbent air, while the close-pored clay imprisons the carbon dioxide and prevents or retards its escape into the air above.

The disappearance of oxygen from the ground-atmosphere is coincident with the production of an equivalent amount of carbon dioxide. It appears from this that in the soil an oxidation of carbonaceous substances takes place, the product of which is found in the excess of carbon dioxide in the ground-air.

Professor Nichols has found the proportion of carbon dioxide in the air taken from a depth of 3 metres below the surface in the "made-land" of Boston to amount to 21.21 per thousand, the observation having been made in August. In December, at a depth of 2 metres, the proportion was 3.23 per thousand. Fodor, in Buda-Pesth, found the proportion of carbon dioxide to be 107.5 per thousand (over 10 per cent.), the air having been taken from a depth of 3 metres.

The ground-air also teems with micro-organisms of various kinds, these being occasionally pathogenic. While in the great majority of instances the micro-organisms found are ordinary mold or fermentation fungi and bacteria of decay and putrefaction, disease-producing bacilli have also been observed in a

number of instances. Among the latter are the bacillus of tetanus (Nicolaier), of anthrax (Frank), of malaria (Klebs and Tommasi-Crudeli),[1] of malignant œdema (Koch and Gaffky), and of typhoid fever (Tryde).

It may not be inappropriate to refer here to the claim of Professor Domingos Freire, of Brazil, to the discovery of the germ of yellow fever in the soil of a burial ground near Rio Janeiro. The exhaustive investigations of Dr. G. M. Sternberg, of the U. S. Army, under the direction of the government, have disposed effectually of the claims and pretensions of the Brazilian scientist, and established the fact that Freire's organism has no pathological significance whatever,—at all events, that it has no relation to yellow fever.

Cholera bacilli have not been found in the soil, but C. Fränkel has shown experimentally that they can grow and multiply in the soil at various depths. At a depth of $1\frac{1}{2}$ metres their development was constant and progressive throughout the year.

When the soil is dry, these organisms may be carried hither and thither in the movements of the ground-air, and thus infect the air of contiguous localities, or be transported to a distance.

Movements of the ground-atmosphere are principally due to differences of pressure and temperature in the air above-ground. Owing to such differences the air from the soil frequently permeates houses, entering from cellars or basements. In winter, when the air of houses is very much more heated (and consequently less dense) than the air out-of-doors, the difference of pressure thus caused draws the ground-air up through the house, while the cold, external atmosphere penetrates the soil and occupies the place of the displaced ground-air.[2] A similar effect occurs in consequence of heavy rains.

[1] While the pathogenic significance of Klebs' *bacillus malariæ* is not generally accepted, it is thought proper, for the sake of completeness, to include it among the organisms sometimes found in the soil.

[2] It is, of course, not strictly correct to say that the air *is drawn up* through the house by the diminution of pressure; it being rather *forced* out of the soil by the colder and denser outside air; but the phrase is sufficiently exact and will be readily understood.

The water fills up the interstices of the soil near the surface, and forces the ground-air out at points where the pores remain open. These places are the dry ground under buildings, where the air escapes and passes through floors and ceilings into the house above. Heavy rains may thus be the cause of pollution of the air in houses. The greater the porosity of the soil, the more likely is this to happen. This pollution of the house-air may be prevented by having impervious floors and walls to cellars and basements, or by interposing a layer of charcoal between the ground and the floor of the house. The latter does not prevent the passage of the ground-air, but the charcoal layer absorbs or arrests the noxious matters,—filters the ground-air, as it were.

In the spring and early summer the ground being colder than the air above it, and the ground-air consequently heavier and denser, the latter is not easily displaced. It is, perhaps, due to this fact that those infectious diseases which are probably dependent upon the movements of the ground-air are less prevalent in the spring and early summer than in the latter part of the summer, autumn, and early winter. In the autumn the ground-air being warmer than the air above ground is easily displaced by the latter and forced out into the streets and houses to be inspired by men and animals. The same conditions may explain the greater likelihood of infection at night, which is proven for such diseases as malarial and yellow fevers. The colder outside air penetrates the interstices of the soil and forces out the impure ground-air.

The researches of Fodor have demonstrated that the proportion of carbon dioxide in the ground-air may be taken as an approximative measure of the impurity of the soil whence the air is taken. The influence of the permeability of the soil, as before pointed out, must, however, not be overlooked in estimating the signification of the carbon dioxide. Fodor has shown that the proportion of carbon dioxide in the ground-air, and consequently the amount of organic decomposition, is

greatest in July and least in March. That the carbon dioxide is derived from the decomposition of vegetable matter has been proven by Pettenkofer. This observer examined specimens of air brought from the Lybian desert, and found that the proportion of carbon dioxide in the ground-air was exactly the same as in the air collected above-ground. There being no vegetable growth in the desert there can, of course, be no vegetable decomposition going on in the soil.

The excess of carbon dioxide in the ground-air is an indication of the deficiency of oxygen, as has been shown. The air at a depth of 4 metres below the surface was found to contain only from 7 to 10 per cent. of oxygen—one-half to one-third of the normal proportion. Many basements occupied by people as living-rooms extend from 1 to 3 metres under-ground, and hence are liable to be supplied with an atmosphere approaching in impurity that just mentioned. It requires no very vivid imagination to appreciate the dangers to health that lurk in such habitations.

THE WATER OF THE SOIL, OR GROUND-WATER.

At a variable depth below the surface of the ground, a stratum of earth or rock is found through which water passes with difficulty, if at all. Above this there is a stratum of water which moves from a higher to a lower level, and which varies in depth at different times according to the amount of precipitation (rain- or snow- fall), and according to the level of the nearest body of water toward which it flows. This stratum of water is termed the *ground-water*, and has within the last few years assumed considerable importance from its apparently close relations to the spread of certain of the infectious diseases. The direction of horizontal flow of ground-water is always toward the drainage-area of the district. Thus, it is usually toward lakes, rivers, or the sea. Rains, or a rise in the river, cause a rise in the ground-water, while long-continued dry weather, or a low stage of the river which drains off the ground-water,

causes a fall in the latter. On the sea-coast the ground-water oscillations probably correspond with the tides. The writer is not aware of any observations made to determine this point, with the exception of a single instance mentioned by Dr. De Chaumont. In Munich, where the ground-water flows toward the river Isar, which divides the city, it has been found that the annual range or oscillation (the difference between the highest and lowest level during the year) is 3 metres, while the horizontal movement amounts to 5 metres per day. In Buda-Pesth the annual range was found by Fodor to be less than 1 metre, while in some portions of India it amounts to more than 12 metres. As it is from the ground-water that the greater portion of the supply of drinking-water in the country and in villages and small towns is drawn, it becomes at once manifest how important it is to prevent, as far as possible, pollution of this source. Cess-pools and manure-heaps and pits, of necessity, contaminate the soil and also ground-water for a distance below and around them, and such water is clearly unfit for drinking and other domestic purposes. Hence, the reason why wells should not be placed too near privies and manure-heaps or pits becomes apparent.

Between the level of the ground-water, or that portion of the soil where its pores are entirely occupied by the water—where, in other words, the ground is *saturated*—and the surface, is a stratum of earth more or less *moist;* that is to say, the interstices of the soil are partly filled with water and partly with air. It is in this stratum that the processes of organic decay or putrefaction are most rapidly going on, in consequence of which the pollution of the ground-air occurs. The oxidation of non-nitrogenous matter in the soil results in the formation of carbon dioxide. On the other hand, nitrogenized compounds are oxidized into nitric acid and nitrates. When, however, putrefaction occurs, nitrous acid, or nitrites and ammonia, are formed, the oxidation not proceeding far enough to result in nitric acid.

Recent observations seem to show that these processes of

decomposition are initiated and kept up by minute organisms termed *bacteria*, just as fermentation in liquids containing sugar can only take place in the presence of the yeast-plant. It has been found that when non-putrefactive decomposition goes on, there are always present multitudes of one variety of these minute organisms; while if putrefactive decomposition is going on, a number of other varieties of these organisms are present. Just as, when a fermenting liquid becomes putrid, the yeast-plant disappears and its place is taken by the ordinary bacteria of putrefaction, so in the soil, if the access of oxygen, which is necessary to the life of the bacteria of decay, is prevented, these organisms die and are succeeded by the organisms of putrefaction. It has been found that in a soil saturated with water the bacteria of decay cannot live, while those of putrefaction may flourish, because these latter organisms can sustain life and develop in the absence of oxygen. Professor Fodor's researches indicate that the most prominent organism of non-putrefactive decomposition or decay is that which is termed by Cohn *bacterium lineola;* and that the *bacterium termo* is the principal organism of putrefaction.

DISEASES SPREAD BY SOIL IMPURITIES.

Given now an area of soil, say the ground upon which a house or city is built, with a moist stratum in which the processes of decay are active, and imagine a rise in the ground-water. The ground-air, charged with carbon dioxide and other products of decomposition, is forced out of the pores of the soil by the rising ground-water, and escapes into the external air, or through cellars and basements into houses, and may there produce disease. But the saturation of the soil with water prevents the further development of the bacteria of decay, and this is checked, or putrefaction may take place. If now the ground-water sinks to its former level or below, the processes of decay again become very active in the moist stratum, and large quantities of carbon dioxide and other inorganic compounds are produced. If the germs of infectious or contagious diseases

have been introduced into the soil, they also multiply and may escape with the movements of the ground-air into the external atmosphere, and there produce their infective action. This, it is held by Pettenkofer and his followers, is what actually occurs in cholera and typhoid fever. Professor DeChaumont has laid down the rule that a soil with a persistently low stage of ground-water, say 5 metres below the surface of the ground, is healthy; a persistently high stage of ground-water, less than $1\frac{1}{2}$ metres below the surface, is unhealthy; while a fluctuating level of the ground-water, especially if the changes are sudden and violent, is very unhealthy. This would lead us to expect that places where this fluctuation is very great would show a large mortality from such diseases as are attributed to impurities in the soil. And this we find especially true in India. In certain localities in India, cholera, for example, is endemic; that is to say, the disease is never entirely absent in such localities. Calcutta is one of these places. The rainy season begins about the first of May and continues until the end of October. During the next six months there is very little rain. It is fair to assume that the ground-water rises during the rainy season and checks decay and the multiplication of the germs of the disease in the soil, and that these processes become more active as the dry season advances and the ground-water level falls. If we note the death-rate from cholera in Calcutta it will be found that it bears a distinct relation to the movement of the ground-water. The deaths from cholera begin to increase from October and reach their height in April. Dr. Macpherson, who has written a very elaborate history of Asiatic cholera, shows this relation very clearly. For twenty-six years the average rain-fall was 157 centimetres. From May to October 142 centimetres fell, while the remaining 15 centimetres fell from November to April. The average number of deaths from cholera annually was 4013. Of these, 1238 died in the rainy season, while 2775, nearly three-fourths, died during the period of dry weather.

In the cholera epidemics of 1866 and 1873 in Buda-Pesth,

the same relations existed between the ground-water and the cholera. As the level of the ground-water rose the cholera diminished, while the disease increased upon the sinking of the ground-water. Exactly the same behavior was exhibited by the disease in Munich in 1873.

There seems good reason to believe that typhoid fever is propagated in consequence of movements of the ground-water, in the same way as above explained for cholera. This does not exclude the infection of drinking-water by the disease-germ, since much of the drinking-water used, as before stated, is drawn from the ground-water. Pettenkofer, Buhl, and Virchow have shown that the death-rate from typhoid fever has a distinct and definite relation to the ground-water oscillations. This has been incontestably proven for two cities, Munich and Berlin. When the level of the ground-water is above the average, typhoid fever decreases; when it is below the average, the number of cases becomes greater. Dr. H. B. Baker has demonstrated that the fluctuation of the ground-water level in the State of Michigan is similarly followed by a change in the morbility and mortality from typhoid fever.[1] Hence, it may be regarded as an established law that the rise and fall of the ground-water bears a definite relation to the morbility rate of typhoid fever.

Nearly thirty years ago Dr. Henry I. Bowditch, of Boston, called attention to the frequent connection between cases of pulmonary consumption and dampness of the soil upon which the patients lived. After a very extended and laborious investigation Dr. Bowditch formulated these two propositions:—

"*First.*—A residence in or near a damp soil, whether that dampness be inherent in the soil itself or caused by percolation from adjacent ponds, rivers, meadows, or springy soils, is one of the principal causes of consumption in Massachusetts, probably in New England, and possibly other portions of the globe.

"*Second.*—Consumption can be checked in its career, and

[1] The Relation of the Depth of Water in Wells to the Causation of Typhoid Fever, Public Health, vol. x, p. 184-213.

possibly—nay, probably—prevented in some instances by attention to this law."[1]

Dr. Buchanan, of England, about the same time showed that the thorough drainage of certain English cities had markedly diminished the deaths from consumption in the drained cities. So far as the writer is aware, not a single fact has been established which militates against the law laid down by Dr. Bowditch, and so strongly supported by the statistical researches of Dr. Buchanan, yet hardly any notice has been taken of these results by physicians. Few know anything of them, and still fewer seem to have made practical use of such knowledge in advising patients. As corroborative of the views of Dr. Bowditch, the rarity of consumption in high and dry mountainous districts or plateaus may be cited.

A recent study of the topographical distribution of consumption in the State of Pennsylvania, by Dr. William Pepper, apparently confirms Dr. Bowditch's conclusions in nearly every particular. It is now known that the direct cause of consumption is the bacillus tuberculosis, discovered by Dr. Robert Koch. The relation between soil-moisture and the increase of consumption will probably be found in the more favorable conditions of development of the tubercle bacillus furnished by a moist medium.

DISEASES OF ANIMALS PROBABLY DUE TO SIMILAR CONDITIONS OF THE SOIL.

The modern study of the sanitary relations of the soil is still in its infancy. Whatever definite knowledge has been gained relates merely to physical or chemical conditions of the soil and its atmosphere and moisture, or possibly the relations of these to the spread of certain diseases in human beings. But there is, perhaps, a wider application that may be made of such knowledge than has been heretofore suggested. The domestic animals which form such a large portion of the wealth of this

[1] Consumption in New England and Elsewhere, 2d ed., p. 87. Boston, 1866.

country—horses, cattle, sheep, and hogs—are liable to infectious and contagious diseases, as well as are human beings, and many millions of dollars are lost annually by the ravages of such diseases. Now, from what is known of such diseases as *splenic fever* among cattle, and of the so-called *swine plague*, it does not appear improbable to the writer that the source of infection is a soil polluted by the poisonous germ of these diseases, just as it seems demonstrated that cholera and typhoid fever and possibly malarial fevers are so caused. The laborious investigations of M. Pasteur in France have shown that the cause of splenic fever, when once introduced into a locality, will remain active for months, and even years, and it seems probable that a study of the soil in its relations to the diseases of domestic animals is a subject to which attention may profitably be given.

It is well known that milch-cows frequently suffer from a disease identical in its nature with consumption in human beings. It is believed by many that the milk of such animals is not only unfit for food by reason of its poor quality, but that it may convey the disease to human beings when used as food. The observations of Bowditch and Buchanan, quoted above, show that consumption in man may be, and doubtless is, frequently caused by soil-wetness. It seems probable that the same cause should produce similar effects in the lower animals, and it is the writer's firm conviction that an examination into the circumstances under which cows become attacked by consumption would prove this probability a fact.

DRAINAGE.

In many soils drainage is necessary in order to secure a constant level of the ground-water at a sufficient depth below the surface. Drainage and sewerage must not be confounded with each other. Drainage contemplates only the removal of the ground-water, or the reduction of its level, while sewerage aims to remove the refuse from dwellings and manufactories,

including excrementitious matters, waste-water, and other products, and in some cases the storm-water.

Sewers should never be used as drains, although for economy's sake sewer- and drainage- pipes may be laid in the same trench. Sewer-pipe must be perfectly air-tight and water-tight to prevent escape of its liquid or gaseous contents into the surrounding soil and rendering it impure. Drainage-pipe, on the other hand, should be porous and admit water freely from without. Escape of the contents of the drain-pipe into the surrounding soil will not produce any pollution of the latter.

The best material for drains is porous earthenware pipe, or the ordinary agricultural drain-tile. Coarse gravel or broken stones may also be used, and prove efficient if the drains are properly constructed. Referring again to the aphorism of Professor DeChaumont, that a persistently low ground-water, say 5 metres down, or more, is healthy; that a persistently high ground-water, less than $1\frac{1}{2}$ metres from the surface is unhealthy; and that a fluctuating level, especially if the changes are sudden and violent, is very unhealthy, the necessity appears obvious that in the construction of drainage-works the drains should be placed at a sufficient depth to secure a level of the ground-water consistent with health. This depth should never be less than 3 metres, and, if possible, not less than 5 metres. Care must be taken that the outflow of the drain is unobstructed, in order that the soil may be kept properly dry at all times.

In the absence of a proper mechanical system of drainage, the planting of certain trees may efficiently drain the soil. It has been found that the eucalyptus tree has produced drying of the soil when planted in sufficient numbers in marshy land. The roots absorb a prodigious quantity of water, which is then given off by evaporation from the leaves. Sunflower-plants have a similar effect upon wet soils.

CHAPTER V.

Removal of Sewage.

In all larger communities certain arrangements are necessary to secure a prompt and efficient removal of excreta and the refuse and used water of households and manufacturing establishments, the sweepings of streets, and rain-water.

The total quantity of excrementitious products—fæces and urine—for each individual, including men, women, and children, has been estimated by Professor von Pettenkofer as 90 grammes of fæcal and 1170 grammes of urinary discharge daily. This would give for a population of 1000 persons 34,000 kilogrammes of fæces and 428,000 litres of urine per year. If to this is added a minimum allowance of 159 litres of water per day to each individual, a complete sewerage system for a population of 1000 persons would require provision for the discharge of 160,000 litres of sewage passing through the sewers every day. In this estimate storm-water and such accessory feeders of the sewage are omitted.

The organic matters contained in sewage, even if free from the specific germs of disease, give rise to noxious emanations, which, when inhaled, probably produce a gradual depravement of nutrition that renders the system an easier prey to disease. For this and other reasons it is important that such measures be adopted as will secure the removal of sewage matters from the immediate vicinage of houses as quickly as possible after they have been discharged.

The impregnation of the soil with sewage produces a contamination of ground-air and ground-water, which may become a source of grave danger to health. By polluting the ground-water it eventually vitiates the well-water, which is nearly always derived from that source.

The system of removal of excrementitious matters which any community will adopt depends to a considerable extent upon financial considerations. Although the sanitarian must insist upon the pre-eminent importance of the cause of public health, his suggestions will receive little attention from municipal or state legislatures unless they can be carried out without involving the community too deeply in debt. For this reason it is a matter of great practical importance that the student of sanitary science should make himself familiar with the relative cost as well as with the hygienic significance of the various methods of sewage removal in use.

The different systems in use for the removal of sewage matters may be considered in detail under the following five heads:—

1. The common privy, or privy-vault systems.
2. The Rochdale or pail system, and its modifications.
3. The earth- or ash- closet system.
4. The pneumatic system of Liernur.
5. The water-carriage systems.

1. *The Privy and Privy-well Systems.*—While from a sanitary point of view privies of all kinds, whether wells or cess-pits, are to be unreservedly condemned, it is not likely that they will cease to be built for many years to come. It becomes necessary, therefore, to point out by what means the objections against them may be diminished, and their evil consequences in some measure averted.

In the first place, a privy-vault should be perfectly water-tight in order to prevent pollution of the surrounding soil by transudation of the contained excremental matters. The walls should be of hard-burned brick laid in cement. The cavity should be small in order that the contents may be frequently removed, and not allowed to remain and putrefy for months or years. A water-tight hogshead sunk in the ground makes an economical privy-tank or receiver. A privy must not be dug in a cellar, or in too close proximity to the house-walls. Unless

these last precautions are taken the offensive gases from the mass of decomposing fæcal matter in the privy will constantly ascend into and permeate the air of the house.

All privies should be ventilated by a pipe passing from just under the privy-seat to a height of about a metre above the roof of the house. A gas-flame, kept burning in the upper portion of this pipe, will increase its ventilating power by creating a strong and constant upward current.

Deodorization of the contents of privies may be secured in a measure by means of sulphate of iron, phenyle, carbolic acid, or dry earth. The first named is probably the most economical, most easily applied, and very effective. A solution containing from ½ to 1 kilogramme of the salt in 4 litres of water is poured into the privy as often as necessary to prevent offensive odors. This solution may be conveniently prepared by suspending a basket or bag containing about 25 kilogrammes of the sulphate in a barrel of water. In this way a saturated solution will be maintained until the salt has been entirely dissolved. Phenyle is likewise a good deodorizer as well as an excellent disinfectant.

The most rigid deodorization by chemicals will, however, be less effective than thorough ventilation, for it must be remembered that the mere destruction of an offensive odor is not equivalent to removing all the deleterious properties that may be present. It is not at all certain that those elements of sewage which are the most offensive to the sense of smell are most detrimental to health.

Privies should be emptied of their contents at stated intervals. A strict supervision should be exercised over them by the municipal authorities in cities and towns to prevent overflowing of their contents.

In many places the method of removing the contents of privies is the primitive one with shovel, or dipper and bucket. In most cities and large towns, however, the privy-vaults or tanks are now emptied by means of one of the so-called odorless excavating machines, of which there are a number of different patents.

The process is rarely entirely odorless, however, as the carelessness of the workmen frequently permits offensive gases to escape and pollute the air for a considerable distance. All the different forms of the apparatus act upon the pneumatic principle. One end of a large tube is carried into the cess-pool or vault to be emptied and the other attached to a pump, by means of which the material is pumped into a strong barrel-tank carried on wheels. At the top of the tank is a vent, over which is placed a small charcoal furnace to consume the foul gases escaping from the vent.

In some cities and many of the smaller towns and villages in this country the primitive midden or pit system is still in use. A shallow pit is dug in the ground, over which is erected the privy. When the pit is full another is dug close by the side of it, and the earth from the new pit thrown upon the excrement in the old one. The privy is then moved over the new pit, and this is used until it too becomes full. The proceeding is repeated as often as the pit becomes filled up with the excreta, until in the course of a few years all the available space in a yard has been honey-combed with the pits. Then the custom adopted in overcrowded cemeteries is followed, namely, the first pit is dug out again and the cycle is repeated.

In other cities the privy-well system is largely in use. This is—next to the midden or shallow pit just described—the most pernicious system for the disposal of excreta that can be imagined. The wells are dug to such a depth as to reach the subterranean flow of water, in which the excremental matters are constantly carried off. Hence these receptacles never fill up, and never need cleaning. For this reason they are popular with property owners; for, next to the primitive midden, they are the most economical of all the various methods adopted. The utter perniciousness of the system is, however, plain, because the soil for a considerable distance around each of these wells becomes a mass of putrid filth, contaminating the ground-water which feeds the drinking-water supplies in the vicinity; polluting also

the ground-air, which eventually reaches the surface, or the interior of houses, when the pressure of the outside atmosphere diminishes or the ground-water level rises. It must, therefore, be evident that the best ventilating arrangements, or the most thorough and consistent disinfection, can have very little, if any, effect in removing the very grave objections to this baneful system.

The privy-well system for the removal of excreta cannot be recommended for adoption by any sanitarian.

2. *The Rochdale, or Pail-closet System.*—The Rochdale system of removal of excreta has won the support of many distinguished sanitarians on account of its simplicity, its economy, and its compliance with most sanitary requirements. The excreta, both solid and liquid, are received into a water-tight pail, either of wood or metal, and removed once or oftener a week, a clean and disinfected pail being substituted for the one removed. In Rochdale, Manchester, and Glasgow in Great Britain, in Heidelberg in Germany, and in other cities abroad, where this system has been introduced, it has worked satisfactorily. In this country a modification of the pail system, known as the Eagle Sanitary Closet, has been introduced by a firm in Charleston, S. C. The receptacle consists of an enameled-iron reservoir, with a neck just large enough to fit under the seat of the privy, and a quantity of disinfectant solution is put into the receptacle to prevent putrefaction of the excreta. The receptacles are replaced by clean ones every week.

Mr. James T. Gardner, Director of the New York State Sanitary Survey, says, in a special report on methods of sewerage applicable in small towns and villages, concerning the pail system[1]:—

"Rochdale is a city of some 70,000, and Manchester of between 400,000 and 500,000 inhabitants. The higher class of houses are allowed to have water-closets, but four-fifths of the people are obliged to have 'pail-closets' in their yards built

[1] Second Annual Report of New York State Board of Health, pp. 322, 323.

according to plans of the Health Department. Their essential features are: A flag-stone floor, raised a few inches above the level of the yard; a hinged seat, with a metal rim underneath for directing urine into the pail, which stands on the flag directly beneath the seat; a hinged front and back to the seat, so that the pail or tub may be easily taken out and the place cleaned; and a 6-inch ventilating pipe from under the seat to above the roof. In Rochdale they use a wooden pail or tub made of half of a disused paraffine cask, holding about 40 kilogrammes; in Manchester the 'pail' is of galvanized iron and holds 40 litres. Under the direction of the authorities, they are removed once a week in covered vans, which bring clean tubs to be put in the place of the full ones taken away. Each tub is covered with a close-fitting double lid before removal. The tubs are taken to a depot, where their contents are deodorized and prepared as manure by mixing with ashes and a small proportion of gypsum to fix the ammonia. Subsequently, street-sweepings and the refuse of slaughter-houses are added. At Manchester there is by the side of each closet a very simple ash-sifter, from which the ashes fall into the tub and help to deodorize its contents.

"The manure at Rochdale sells for about four-fifths of the cost of the collection and preparation.

"In 1873 the net cost to the town of removing and disposing of the house dry refuse and excrement was only about $95 per annum per 1000 of population,—less than 10 cents a person per annum.

"The system has been in operation more than twelve years.

"The tubs are removed in the day-time without offensive odor.

"Where ashes are frequently thrown into the tubs at Manchester, very little odor is to be perceived in the closets.

"For the villages of the State, which can have no general water-supply, I would unhesitatingly advise the use of the 'pail' or tub system as practiced in Manchester, England, as being, from a sanitary point of view, an immense improvement

over the death-breeding *privy-vaults* in common use. The cheapness of the plan and the smallness of the original outlay of brains and money, in comparison with that needed to build a good sewer system, will make it possible to introduce a tub-privy system into most villages half a century before sewers would meet with any consideration.

"At a small cost the existing privy-vaults can be cleaned and filled, and the privies altered into healthful tub-closets. The town authorities must then arrange for the removal of the tubs once a week, and for their thorough cleansing and disinfecting. Any isolated house, or group of houses, can use the tub system, taking care of it themselves. If the plan is adopted in villages it will doubtless spread into the country, and become the most powerful means of abolishing the fatal privy-vaults which are poisoning the farm-wells."

3. *Earth- and Ash- Closets.*—The earth- and ash- closets are devices in use to a large extent in England, and to a less degree in this country, for the purpose of rendering human excreta inodorous by covering them immediately after they are voided with dry earth or ashes. The earth-closet is the invention of the Rev. Henry Moule, of England, and consists of an ordinary commode or closet, the essential feature of which is a reservoir containing dried earth or ashes, a quantity of which, amounting to about twice the quantity of fæces voided, is thrown upon the evacuation either by hand or by means of an automatic apparatus called a "chucker." Just as in the ordinary water-closet, by raising a handle a supply of water is thrown into the hopper to wash down the fæces into the soil-pipe, so, in the usual form of the earth-closet, raising the handle projects a quantity of earth upon the evacuated fæces and urine. By this means the excreta are rendered entirely inodorous and dry. The contents of the closets may be collected into a heap in a dry place. In the course of a few months the organic constituents have become oxidized, and the earth may be used over again for a number of times. A well-known sanitarian states

that he has used sifted anthracite coal-ashes ten or twelve times over in the course of three years. During this time the material under no circumstances gave any indication that it was "anything but ashes, with a slight admixture of garden soil."[1]

Dr. Buchanan, of England, comparing the advantages of the earth-closet with those of the water-closet, says: "It is cheaper in original cost; it requires less repairs; it is not injured by frost; it is not damaged by improper substances being

FIG. 4.—PULL-UP HANDLE COMMODE, SHOWING THE DOOR OPEN FOR REMOVING PAIL. THE FLAP OF THE SEAT AND EARTH-RESERVOIR ARE ALSO PARTIALLY RAISED TO SHOW THE CONSTRUCTION.

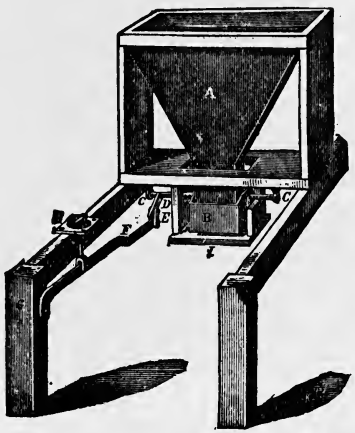

FIG. 5.—SHOWING THE APPARATUS MOUNTED ON BEARERS AS WHEN FIXED. SEAT REMOVED, SHOWING MECHANICAL ARRANGEMENT.

thrown down it; and it very greatly reduces the quantity of water required by each household."[2]

In cities and towns the removal of the excreta should be carried out by or under the immediate direction of the municipal sanitary authorities. If this is neglected, abuses are liable to creep in which will vitiate the performance of any system, however faultless, if properly managed.

Many advocates of the pail, dry earth, or privy systems urge the advantage of the large quantity of valuable manure which

[1] The Sanitary Drainage of Houses and Towns, Waring, p. 250. 2d ed., 1881.
[2] Quoted in Waring, above cited, p. 264.

can be realized by converting the excremental matters into poudrette and other fertilizing compounds. Experience has shown, however, that the cost of preparing a satisfactory fertilizer from human excrement is much greater than can be realized from its sale. In all places in Great Britain and the continent of Europe where it has been tried the decision is against its practicability. The agricultural consideration should, however, be a secondary one, if the systems mentioned are economical and meet the sanitary requirements (which the privy system certainly does not). The adoption of one or other of them may be secured where more perfect but more complicated and expensive systems may be out of the question.

4. *The Pneumatic System of Liernur.*—A system which seems to be useful in larger cities, especially where the topographical conditions are such as to render necessary mechanical aid in overcoming obstacles to natural drainage, is the pneumatic system devised by Captain Liernur, of Holland, and generally known as the Liernur system. It consists of a set of soil-pipes running from the water-closets to central district reservoirs, from which the air is exhausted at stated intervals. When a vacuum is created in the reservoir the contents of the water-closets and soil-pipes are driven forcibly into the reservoir by the pressure of air. The district reservoirs are connected by a separate system of pipes with a main depot, and the transfer of the fæcal matter from the former to the latter is also accomplished with the aid of pneumatic pressure. The complete system of Liernur provides that at the main depot the fæcal matter shall be treated with chemicals, evaporated, and converted into a dry fertilizer—poudrette. It appears from the published reports that while the system has been partially adopted in three Dutch cities, in only one of them, Dortrecht, has the machinery for manufacturing poudrette been established. With reference to this Erismann[1] says: "It seems never to have

[1] Von Pettenkofer und Ziemssen. Handbuch der Hygiene. II Th., II Abth, 1 Hlfte, p. 140.

been in regular working order, for the fæcal masses are mixed with street-sweepings and ashes into a compost-mass, which causes no little discomfort in the neighborhood by the offensive odors. In Amsterdam the fæcal matters, which frequently do not find a ready sale, are partly made into a compost with sweepings, partly used to fertilize meadows, or simply discharged into the water."

As to the practical working of the system the opinions differ widely. While the majority of sanitarians, including Virchow, von Pettenkofer, and Mr. Rawlinson, object to it as not fulfilling the demands of hygiene, the system has also been criticized by engineers as not being in accordance with the well-known principles of their science.[1]

Two other plans for the removal of fæcal matter by pneumatic pressure have been invented, namely, the Shone and the Berlier systems. Neither of these has been adopted to any considerable extent. Both seem to the author to fall far short even of the merits of the Liernur system.

5. *The Water-Carriage System of Sewerage.*—Two systems of removal of sewage by water-carriage are in use at the present time. They are technically known as the "combined" and the "separate" systems. In the former, which is the system upon which the most of the sewers in this country are constructed, all excreta, kitchen-slops, waste-water from baths and manufacturing establishments, as well as storm-water, are carried off in the same conduits. In the separate system, on the other hand, the removal of the storm-water is provided for, either by surface or under-ground drains, not connected with the sewers proper, in which only the discharge from water-closets and the refuse-water from houses and factories are conveyed. In the separate system the pipes are of such small calibre that a constant flow of their contents is maintained, preventing

[1] Papers by Maj. C. H. Latrobe and Col. Geo. E. Waring, Jr., in Fifth Biennial Report Md. State Board of Health. See also, in favor of system, a paper by Dr. C. W. Chancellor, in same publication, and an elaborate description by the same author in Trans. Med. and Chir. Faculty of Md., 1883.

deposition of suspended matters and diminishing decomposition and the formation of sewer-gas.

In the combined system, on the other hand, the sewers must be made large enough to receive the maximum rain-fall of the district. This requires a calibre greatly in excess of the ordinary needs of the sewer, and furnishes favorable conditions for the formation of sewer-gas and the development of minute vegetable organisms. The ordinary flow in a sewer of large calibre is usually so sluggish as to promote the deposition of solid matters and the gradual obstruction of the sewer.

It is the opinion of the most advanced sanitarians that the separate system fulfills the demands of a rational system of sewerage better than any other at present in use. The objections to the combined system are so many and so great that it does not seem advisable for sanitary authorities to recommend the construction of sewers on this principle in the future.

The separate system of sewerage, indorsed as it is by high engineering and sanitary authorities, and by a satisfactory, practical test of nine years in the city of Memphis and of six years in the town of Keene, N. H., seems to the author to possess merits above any other plan for the removal of excreta and house-wastes. The following description is from a paper by Col. George E. Waring, Jr.: "A perfect system of sanitary sewerage would be something like the following: No sewer should be used of a smaller diameter than 6 inches (15 centimetres): *a*, because it will not be safe to adopt a smaller size than 4-inch (10 centimetres) for house-drains, and the sewer must be large enough to surely remove whatever may be delivered by these; *b*, because a smaller pipe than 6-inch would be less readily ventilated than is desirable; *c*, and because it is not necessary to adopt a smaller radius than 3 inches (5 centimetres) to secure a cleansing of the channel by reasonably copious flushing.

"No sewer should be more than 6 inches (15 centimetres) in diameter, until it and its branches have accumulated a

sufficient flow at the hour of greatest use to fill this size half full, because the use of a larger size would be wasteful, and because when a sufficient ventilating capacity is secured, as it is in the use of a 6-inch pipe, the ventilation becomes less complete as the size increases, leaving a larger volume of contained air to be moved by the friction of the current, or by extraneous influences, or to be acted upon by changes of temperature and of volume of flow within the sewer.

"The size should be increased gradually, and only so rapidly as is made necessary by the filling of the sewer half full at the hour of greatest flow.

"Every point of the sewer should, by the use of gaskets or otherwise, be protected against the least intrusion of cement, which, in spite of the greatest care, creates a roughness that is liable to accumulate obstructions.

"The upper end of each branch sewer should be provided with a Field's flush-tank of sufficient capacity to secure the thorough daily cleansing of so much of the conduit as from its limited flow is liable to deposit solid matters by the way.

"There should be sufficient man-holes, covered by open gratings, to admit air for ventilation. If the directions already given are adhered to, man-holes will not be necessary for cleansing. The use of the flush-tank will be a safeguard against deposit. With the system of ventilation about to be described, it will suffice to place the man-holes at intervals of not less than 1000 feet (305 metres).

"For the complete ventilation of the sewers it should be made compulsory for every householder to make his connection without a trap, and to continue his soil-pipe above the roof of his house. That is, every house connection should furnish an uninterrupted ventilation-channel 4 inches (10 centimetres) in diameter throughout its entire length. This is directly the reverse of the system of connection that should be adopted in the case of storm-water and street-wash sewers. These are foul, and the volume of their contained air is too great to be thoroughly ven-

tilated by such appliances. Their atmosphere contains too much of the impure gases to make it prudent to discharge it through house-drains and soil-pipes. With the system of small pipes now described, the flushing would be so constant and complete and the amount of ventilation furnished, as compared to volume of air to be changed, would be so great, that what is popularly known as 'sewer-gas' would never exist in any part of the public drains. Even the gases produced in the traps and pipes of the house itself would be amply rectified, diluted, and removed by the constant movement of air through the latter.

"All house connections with the sewers should be through inlets entering in the direction of the flow, and these inlets should be funnel-shaped so that their flow may be delivered at the bottom of the sewer, and so that they may withdraw the air from its crown; that is, the vertical diameter of the inlet at its point of junction should be the same as the diameter of the sewer.

"All changes of direction should be on gradual curves, and, as a matter of course, the fall from the head of each branch to the outlet should be continuous. Reduction of grade within this limit, if considerable, should always be gradual.

"So far as circumstances will allow, the drains should be brought together, and they should finally discharge through one or a few main outlets.

"The outlet, if water-locked, should have ample means for the admission of fresh air. If open, the mouth should be protected against the direct action of the wind.

"It will be seen that the system of sewerage here described is radically different from the usual practice. It is cleaner, is much more completely ventilated, and is more exactly suited to the work to be performed. It obviates the filthy accumulation of street-manure in catch-basins and sewers, and it discharges all that is delivered to it at the point of ultimate outlet outside the town before decomposition can even begin. If the discharge is of domestic sewage only, its solid matter will be consumed by

fishes if it is delivered into a water-course, and its dissolved material will be taken up by aquatic vegetation.

"The limited quantity and the uniform volume of the sewage, together with the absence of dilution by rain-fall, will make its disposal by agricultural or chemical processes easy and reliable.

"The cost of construction, as compared with that of the most restricted storm-water sewers, will be so small as to bring the improvement within the reach of the smaller communities.

"In other words, while the system is the best for large cities, it is the only one that can be afforded in the case of small towns.

"Circumstances are occasionally such as to require extensive engineering works for the removal of storm-water through very deep channels. Ordinarily, the removal of storm-water is a very simple matter, if we will accept the fact that it is best carried, so far as possible, by surface gutters, or, in certain cases, by special conduits, placed near the surface.

"It is often necessary, in addition to the removal of house-waste, to provide for the drainage of the subsoil. This should not be effected by open joints in the sewers; because the same opening that admits soil-water may, in dry seasons and porous soils, permit the escape of sewage matters into the ground, which is always objectionable.

"Soil-water drains may be laid in the same trench with the sewers, but preferably, unless they have an independent outlet, on a shelf at a higher level. When they discharge into the sewer they should always deliver into its upper part, or into a man-hole at a point above the flow-line of the sewage."[1]

The establishment of a system of sewerage presupposes a constant and abundant supply of water to keep all closets clean and all house-drains and street-sewers well flushed. Where this cannot be obtained, sewers would be likely to prove greater evils than benefits. In such cases one of the methods of removal

[1] The Sewering and Drainage of Cities, Waring, Public Health, vol. v, p. 35.

of excreta before mentioned, either the pail- or earth- closet system, should be adopted.

The final disposal of sewage is a problem that depends for its solution partly upon the agricultural needs of the country around the city to be sewered, partly upon the proximity of large bodies of water or running streams. When the city is situated upon or near large and swiftly-flowing streams, the sewage may be emptied directly into the stream without seriously impairing the purity of the latter, although the principle of thus disposing of sewage is wrong. Dilution, deposition, and oxidation will soon remove all appreciable traces of the sewage of even the largest cities. Where, on the other hand, the stream is inadequate in size to carry off the sewage, or where, as in the Seine and Thames, the current is sluggish, some other method of final disposal must be adopted.

In many cities of Great Britain and the continent of Europe the disposal of the sewage by irrigation of cultivated land has been practiced for a number of years. The reports upon the working of the system are generally favorable, although some sanitarians express doubts of the efficiency of the system. In using sewage for the irrigation of land, two objects are secured: first, the fertilization of the land by the manurial constituents of the sewage, and, second, the purification of the liquid portion by filtration through the soil. The organic matters which have been held back by the soil undergo rapid oxidation in the presence of air and the bacteria of decay, and are converted into plant-food, or into harmless compounds. Sewage irrigation, as practiced in Europe, must make provision for the disposal of a very large proportion of water in the sewage (street-wash, storm-water), which requires much larger areas of land than would be needed if only sewage material proper (water-closet and kitchen-waste) was to be thus disposed of. In this country a practical experiment has recently been made at Pullman, Illinois, delivering only the sewage materials above mentioned upon the irrigation area. The success of the experiment is said to be satisfactory.

All land used for sewage irrigation should be drained with drain-tile at a depth of 3 to 6 feet (1 to 2 metres) below the surface, in order to promote a rapid carrying off of the watery portion of the sewage, purified by filtration through the soil. A sandy loam is the best soil for irrigation. Clay is not sufficiently permeable to air and water, while pure sand allows the sewage to pass through too readily, before the organic matters in it have been sufficiently oxidized. It has been shown that the roots of plants assist largely in the oxidation of organic matter.

The entire process of collecting and finally disposing of sewage matters, from the moment they are received in the house-receptacles until discharged into the swiftly-flowing stream or on the sewage farm, should be void of offense to the senses of sight or smell. With a proper construction and management of sewerage works, on the lines indicated in this chapter, it is believed these results can be attained.

During the past two or three years a number of experiments have been made in this country with various processes for the disposal of excreta and garbage by cremation. In a general way the principle may be pronounced a success, although its proper application in practice is still under discussion.

[The following works give fuller details upon the matters treated in the two foregoing chapters:—

Erismann, Entfernung der Abfallstoffe. Hdbch. d. Hygiene, etc., II Th., I Abth., 1 Hlfte.—C. F. Folsom, Seventh Report Mass. State Board of Health, 1876, p. 276.—Soyka, Städte-reinigung, in Realencyclopædie d. ges. Heilk., Bd. xiii, p. 14 *et seq.*—Pettenkofer, The Sanitary Relations of the Soil, in Pop. Sci. Monthly, vol. xx, p. 332, 468.—Rohé, Address on State Medicine, in Journ. Am. Med. Ass'n, July, 1887.—Corfield and Parkes, The Treatment and Utilization of Sewage, 1887.—Reports of the Committee on Destruction of Garbage and Refuse, Public Health, vols. xiv and xv.]

CHAPTER VI.

Construction of Habitations.

The importance of observing the principles of hygiene in the construction of habitations for human beings is not sufficiently appreciated by the public. Architects and builders themselves have not kept pace with the sanitarian in the study of the conditions necessary to be observed in building a dwelling-house which shall answer the requirements of sanitary science.

In an investigation conducted by Dr. Villermé[1] it was found that in France, from 1821 to 1827, of the inhabitants of arrondissements containing 7 per cent. of badly-constructed dwellings, 1 person out of every 72 died; of inhabitants of arrondissements containing 22 per cent. of badly-constructed dwellings, 1 out of 65 died; while of the inhabitants of arrondissements containing 38 per cent. of badly-constructed dwellings, 1 out of every 45 died.

Inseparable from the question of the defective construction of dwellings is that of overcrowding in cities, because the most crowded portions of a city are at the same time those in which the construction of dwellings is most defective from a hygienic stand-point. The following tables show the relations of the death-rate to density of population in various large cities of Europe, and also the relations between overcrowding in dwellings and the mortality from contagious diseases:—

Table XVII.

RELATION OF DEATH-RATE TO DENSITY OF POPULATION.

City.	Mean Number of Inhabitants to each House.	Average Death-rate per 1000 Inhabitants.
London	8	24
Berlin	32	25
Paris	35	28
St. Petersburg	52	41
Vienna	55	47

[1] Quoted in Realencyclopædia d. ges. Heilk, Bd. ii, 71.

In Glasgow, the death-rate in apartments with 1.31 occupants is 21.7 per 1000, while in apartments with 2.05 occupants the rate is 28.6 per 1000.

In Buda-Pesth, in 1872–73, it was found that out of every 100 deaths from all causes there were, from contagious diseases:—

20 deaths in dwellings with 1 to 2 persons in each room.
29 " " " " 3 " 5 " " " "
32 " " " " 6 " 10 " " " "
79 " " " " over 10 " " " "

Dr. Jose A. de los Rios gives the following statistics, bearing upon the mortality of cholera, in relation to the number of persons occupying one room when attacked by it:—

Of 10,000 persons attacked by cholera, and living 1 person to the room, 68 died.

Of 10,000 persons attacked by cholera, from 1 to 2 to the room, 131 died.

Of 10,000 persons attacked by cholera, living 2 to 4 to the room, 219 died.

Of 10,000 persons attacked by cholera, living 4 or more to the room, 327 died.

These figures show very clearly the vital importance of the application of sanitary laws in the construction and occupation of dwellings.

Another curious and suggestive point is presented by some statistical researches on the mortality of Berlin, in regard to the death-rate among persons living in different stories of houses. It was found, for example, that the mortality in fourth-story dwellings is higher than in the lower stories. Even basement dwellings furnish a lower death-rate. Still-births, especially, occur in a larger proportion among the occupants of the upper stories of houses. This may be explained by the unfavorable effects of frequent stair-climbing, especially in pregnant women.

It is in the death-rate among young children that the effects of overcrowding and unsanitary construction of dwellings are especially manifest. The mortality returns from all the large

cities of the world give mournful evidences of this every summer.

The researches of Dr. H. I. Bowditch upon soil-wetness, to which reference has already been made in a previous chapter, show conclusively that persons living in houses situated upon or near land habitually or excessively wet, are especially prone to be attacked by pulmonary consumption. Dr. Buchanan[1] has corroborated the truth of Dr. Bowditch's observations by showing, from the records of a number of cities and towns of Great Britain, that, with the introduction of a good drainage system, bringing about a depression and uniformity of level of the ground-water, the mortality from consumption and other diseases very markedly diminished. The following table, showing the proportionate amount of this diminution, is abridged from the official reports[2]:—

TABLE XVIII.

RESULTS OF SANITARY WORK.

NAME OF PLACE.	Population in 1861.	Average Mortality per 1000 before Construction of Works.	Average Mortality per 1000 since Completion of Works.	Saving of Life (per cent.).	Reduction of Typhoid Fever Rate (per cent.).	Reduction in Rate of Phthisis (per cent.).
Banbury . .	10,238	23.4	20.5	12½	48	41
Cardiff . . .	32,954	33.2	22.6	32	40	17
Croydon . .	30,229	23.7	18.6	22	63	17
Dover . . .	23,108	22.6	20.9	7	36	20
Ely	7,847	23.9	20.5	14	56	47
Leicester . .	68,056	26.4	25.2	4½	48	32
Macclesfield .	27,475	29.8	23.7	20	48	31
Merthyr . .	52,778	33.2	26.2	18	60	11
Newport . .	24,756	31.8	21.6	32	36	32
Rugby . . .	7,818	19.1	18.6	2½	10	43
Salisbury . .	9,030	27.5	21.9	20	75	49
Warwick . .	10,570	22.7	21.0	7½	52	19

The following points must be taken into account in building a house in accordance with sanitary principles:—

I.—SITE.

The building-site should be protected against violent winds, although a free circulation of air all around the house

[1] Ninth and Tenth Reports of the medical officer to the Privy Council.

[2] Sanitary Engineering, Baldwin Latham, p. 2. Chicago, 1877.

must be secured. Close proximity to cemeteries, marshes, and injurious manufacturing establishments or industries must be avoided if possible. A requisite of the highest importance is the ability to command an abundant supply of pure water for drinking and other purposes. A neglect of this precaution will be sure to result to the serious inconvenience, if not detriment, of the occupants of the house.

II.—CHARACTER OF THE SOIL.

The soil should be porous and free from decomposing animal or vegetable remains, or excreta of man or animals. It should be freely permeable to air and water, and the highest level of the ground-water should never approach nearer than 3 metres to the surface. The fluctuations of the ground-water level should be limited. In this connection, attention is again called to the aphorism of Dr. DeChaumont.[1]

It is impossible to say positively that any kind of soil is either healthy or unhealthy, merely from a knowledge of its geological characters. The accidental modifying conditions above referred to, viz., organic impurities, moisture, the level and fluctuations of the ground-water, are of much greater importance than mere geological formation. The late Dr. Parkes, however, regarded the geological structure and conformation as of no little importance, and summarized the sanitary relations of soils, variously constituted, as follows[2]:—

"1. *The Granitic, Metamorphic, and Trap Rocks.*—Sites on these formations are usually healthy; the slope is great, water runs off readily; the air is comparatively dry; vegetation is not excessive; marshes and malaria are comparatively infrequent; and few impurities pass into the drinking-water.

"When these rocks have been weathered and disintegrated they are supposed to be unhealthy. Such soil is absorbent of water; and the disintegrated granite of Hong Kong is said to

[1] Chapter iv, p 130.
[2] Practical Hygiene, 6th ed., vol. i, p. 359.

be rapidly permeated by a fungus; but evidence as to the effect of disintegrated granite or trap is really wanting.

"In Brazil the syenite becomes coated with a dark substance and looks like plumbago, and the Indians believe this gives rise to 'calentura,' or fevers. The dark granitoid, or metamorphic trap, or hornblendic rocks in Mysore, are also said to cause periodic fevers; and iron hornblende, especially, was affirmed by Dr. Heyne, of Madras, to be dangerous in this respect. But the observations of Richter on similar rocks in Saxony, and the fact that stations on the lower spurs of the Himalayas on such rocks are quite healthy, negative Heyne's opinion.

"2. *The Clay Slate.*—These rocks précisely resemble the granite and granitoid formations in their effect on health. They have usually much slope, are very impermeable, vegetation is scanty, and nothing is added to air or drinking-water.

"They are consequently healthy. Water, however, is often scarce, and as to the granite districts, there are swollen brooks during rain, and dry water-courses at other times swelling rapidly after rains.

"3. *The Limestone and Magnesian Limestone Rocks.*—These so far resemble the former that there is a good deal of slope and rapid passing off of water. Marshes, however, are more common, and may exist at great heights. In that case, the marsh is probably fed with water from some of the large cavities which in the course of ages become hollowed out in the limestone rocks by the carbonic acid in the rain, and form reservoirs of water.

"The drinking-water is hard, sparkling, and clear. Of the various kinds of limestone, the hard oolite is best and magnesian is worst; and it is desirable not to put stations on magnesian limestone if it can be avoided.

"4. *The Chalk.*—The chalk, when mixed with clay, and permeable, forms a very healthy soil. The air is pure, and the water, though charged with calcium carbonate, is clear,

sparkling, and pleasant. Goitre is not nearly so common, nor apparently calculus, as in the limestone districts.

"If the chalk be marly, it becomes impermeable, and is then often damp and cold. The lower parts of the chalk, which are underlaid by gault clay, and which also receive the drainage of the parts above, are often very malarious; and in America some of the most marshy districts are in the chalk.

"5. *The Sandstones.*—The permeable sandstones are very healthy; both soil and air are dry; the drinking-water is, however, sometimes impure. If the sand be mixed with much clay, or if clay underlies a shallow sand-rock, the site is sometimes damp.

"The hard millstone-grit formations are very healthy, and their conditions resemble those of granite.

"6. *Gravels* of any depth are always healthy, except when they are much below the general surface, and water rises through them. Gravel hillocks are the healthiest of all sites, and the water, which often flows out in springs near the base, being held up by the underlying clay, is very pure.

"7. *Sands.*—There are both healthy and unhealthy sands. The healthy are the pure sands, which contain no organic matter, and are of considerable depth. The air is pure, and so is often the drinking-water. Sometimes the drinking-water contains enough iron to become hard, and even chalybeate. The unhealthy sands are those which, like the subsoil of the Landes, in southwest France, are composed of silicious particles (and some iron) held together by a vegetable sediment.

"In other cases sand is unhealthy from underlying clay or laterite near the surface, or from being so placed that water rises through its permeable soil from higher levels. Water may then be found within 3 or 4 feet of the surface; and in this case the sand is unhealthy and often malarious. Impurities are retained in it and effluvia traverse it.

"In a third class of cases the sands are unhealthy because they contain soluble mineral matter. Many sands (as, for ex-

ample, in the Punjab) contain magnesium carbonate and lime-salts, as well as salts of the alkalies. The drinking-water may thus contain large quantities of sodium chloride, sodium carbonate, and even lime and magnesian salts and iron. Without examination of the water it is impossible to detect these points.

"8. *Clay, Dense Marls, and Alluvial Soils Generally.*—These are always regarded with suspicion. Water neither runs off nor runs through; the air is moist; marshes are common; the composition of the water varies, but it is often impure with lime and soda salts. In alluvial soils there are often alterations of thin strata of sand, and sandy, impermeable clay. Much vegetable matter is often mixed with this, and air and water are both impure.

"The deltas of great rivers present these alluvial characters in the highest degree, and should not be chosen for sites. If they must be taken, only the most thorough drainage can make them healthy. It is astonishing, however, what good can be effected by the drainage of even a small area, quite insufficient to affect the general atmosphere of the place; this shows that it is the local dampness and the effluvia which are the most hurtful.

"9. *Cultivated Soils.*—Well-cultivated soils are often healthy; nor at present has it been proved that the use of manure is hurtful. Irrigated lands, and especially rice-fields, which not only give a great surface for evaporation, but also send up organic matter into the air, are hurtful. In Northern Italy, where there is a very perfect system of irrigation, the rice-grounds are ordered to be kept 14 kilometres (8.7 miles) from the chief cities, 9 kilometres (5.6 miles) from the lesser cities and the forts, and 1 kilometre (1094 yards) from the smaller towns. In the rice countries of India [and America] this point should not be overlooked."

Where a wet, impermeable, or impure soil must, of necessity, be chosen as a building-site, it should be thoroughly drained. The minimum depth at which drains are laid should

be not less than 1½ metres below the floor of the cellar or basement. Such a soil should be covered with a thick, impervious layer of asphaltum or similar cement under the house, in order to prevent the aspiration of the polluted ground-air into the building.

It is a frequent custom in cities to fill in irregularities of the building-site with street-sweepings and garbage, which always contain large quantities of decomposing organic matters. This is a gross violation of the plainest principles of hygiene. It is almost equally reprehensible to use such decaying or putrefying organic material for the purpose of grading streets or sidewalks in cities and towns.[1] It should be the constant endeavor of all sanitary authorities to prevent pollution of the soil as much as possible in villages, towns, and cities.

Where houses are built on the declivity of a hill, the upper wall should not be built directly against the ground, as it would tend to keep the wall damp. A vacant space should be left between the wall and the ground to permit free access of air and light.

In addition to, or in default of, drainage, the drying of soil can be promoted by rapidly-growing plants, which absorb water from the soil and give it out to the air. The sunflower and the eucalyptus tree are the most available for this purpose.

III.—THE MATERIAL OF WHICH THE HOUSE IS BUILT.

The nature of the most appropriate building material depends upon so many collateral circumstances that definite rules cannot be laid down. As a general rule, moderately hard burned brick is the most serviceable and available material. It is easily permeable by the air, and so permits natural ventilation through the walls, unless this is prevented by other means.

[1] During the very fatal epidemic of yellow fever in New Orleans, in 1878, it was ascertained that a contractor for street-work used the garbage and street-scrapings to grade the bed of the streets. Even though in this case it may not have intensified the epidemic in these localities, the practice is so contrary to the simplest sanitary laws that it should nowhere be tolerated. The author is aware, however, that the "made-ground" of nearly every city in this country is composed largely of just such material. All sanitarians should protest against a continuance of this pernicious practice.

It does not absorb and hold water readily; hence, damp walls are infrequent if brick is used. It is probably, of all building material, the most durable. On account of its porosity a brick wall is a poor conductor of heat. It therefore prevents the rapid cooling of a room in cold weather, and likewise retards the heating of the inside air from without in summer. Another very great advantage is its resistance to a very high degree of heat, brick being probably more nearly fire-proof than any other building material.

In hot climates light wooden buildings are advantageous, because they cool off very rapidly after the sun has disappeared. On account of the numerous joints and fissures in a frame building, natural ventilation goes on very readily and to a considerable extent.

Next to brick, granite, marble, and sandstone are the most serviceable building materials. Very porous sandstone is, however, not very durable in cold climates, as the stone absorbs large quantities of water, which, in consequence of the expansion accompanying the act of freezing, produces a gradual but progressive disintegration.

The application of paint to the walls, either within or without, almost completely checks the transpiration of air through the walls, thus limiting natural ventilation. Calcimining, on the other hand, offers very little obstruction to the passage of air. Wall-paper is about midway between paint and lime-coating in its obstructive effect on atmospheric transpiration.

Newly-built houses should not be occupied until the walls have become dry. Moisture in the walls is probably a not infrequent source of ill health; it offers favorable conditions for the development of fungi (possibly of disease-germs), and, by filling up the pores of the material of which the walls are composed, prevents the free transpiration of air through them.

Moisture of the walls is sometimes due to the ascent of the water from the soil by capillary attraction. This can be

prevented by interposing an impervious layer of slate in the foundation-wall.

Where the moisture is due to the rain beating against the outside walls, and thus saturating them if composed of porous materials, a thorough external coating of impervious paint will prove a good remedy.

IV.—INTERIOR ARRANGEMENTS.

A. Size of Rooms, and Ventilating and Heating Arrangements.—The rooms in dwelling-houses should never be under $2\frac{1}{2}$ metres in height from floor to ceiling. In sleeping-rooms the initial air-space should never be less than 35 cubic metres for adults, and 25 cubic metres for children under 10 years of age. Provision must be made for changing this air sufficiently often to maintain it at its standard of purity; *i.e.*, less than 7 parts of carbon dioxide per 10,000. The details for accomplishing this will vary with the architects' designs, the material of which the house is constructed, the climate, and the season. The principles laid down in the section on ventilation (Chapter I) should be adhered to. In cold weather the air should be warmed, either before its entrance into the room or afterward, by stove or fire-place. Galton's jacketed stove, or fire-place, seems to answer this purpose admirably. The details of the heating apparatus must be left to individual taste, or other circumstances. It may be noted, however, in passing, that the prevailing method of heating houses by means of hot air is objectionable for various reasons; partly, because the air is usually too dry to be comfortable to the respiratory organs; partly, because organic matter is frequently present in large proportions, and gives the air an offensive odor when the degree of heat is high enough to scorch the organic matter. Both these objections are, however, removable; the first, by keeping a vessel of water constantly in the furnace, so that the hot air can take up a sufficient proportion of vapor in passing through, and, the second, by having the furnace made large enough so that the tempera-

ture need never be raised to a very high degree. Heating by hot water or steam is preferable to the hot-air furnace. Both of these methods are, however, more expensive.

Where special ventilating arrangements are necessary, air-

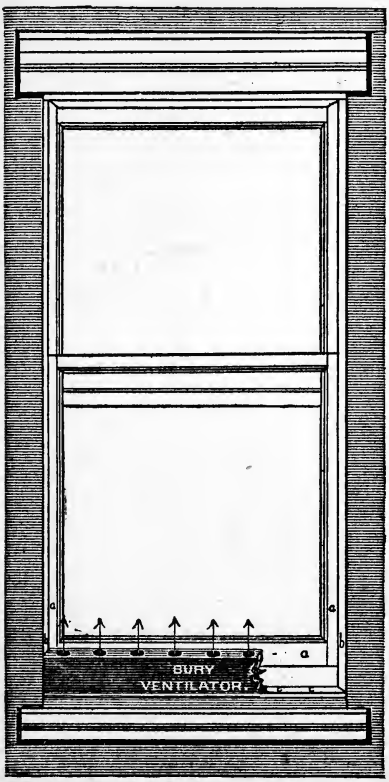

FIG. 6.

a, *a*, sash; *b*, *b*, window-jambs; *c*, *c*, window-sill. This cut represents the view from within the Bury Ventilator, in operation. It is broken away at one end to show the sash raised above the outer holes to admit the air.

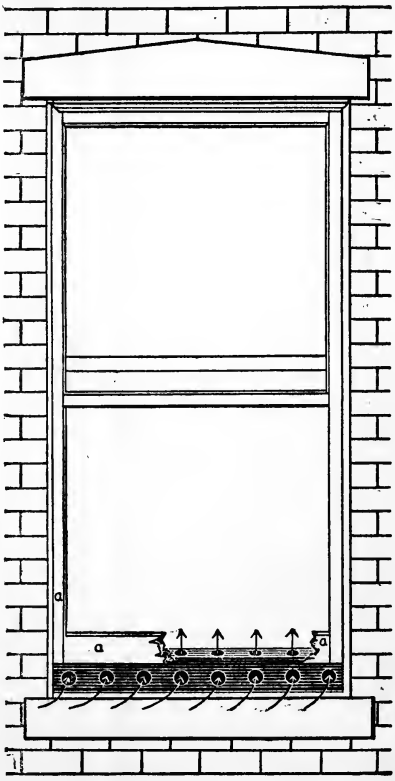

FIG. 7.

a, *a*, sash. This cut represents the view from without the Bury Ventilator, in operation. The *sash* is broken away to show the ventilator behind, with the fresh air passing in.

inlets may be inserted at appropriate points in the walls of the room, facing toward the air. A simple arrangement is that known as the Bury Ventilator, shown in Figs. 6 and 7. It consists of a wooden block interposed between the bottom of the lower

window-sash and the window-frame. The air passes into the room through the openings in the block, as shown in the illustration. The separation of the upper and lower sashes, when the ventilator

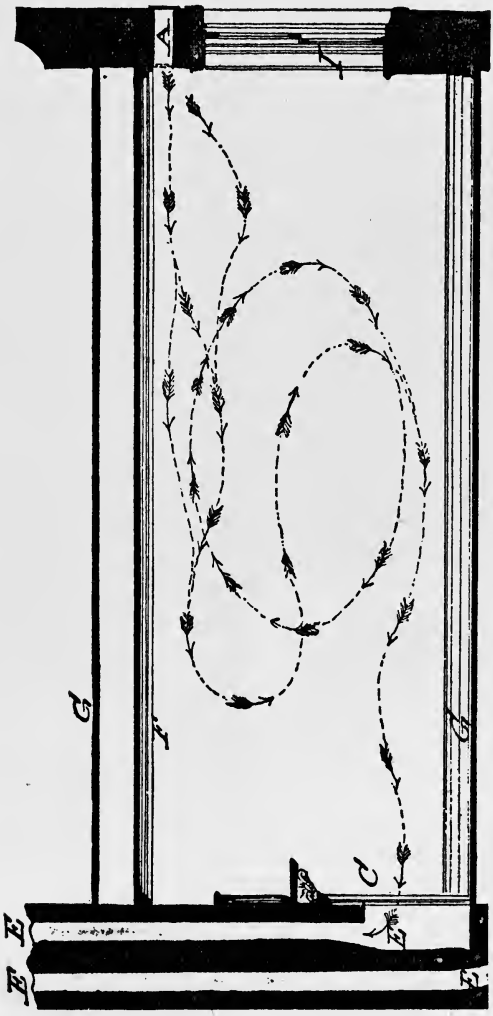

FIG. 8.—VENTILATION OF A ROOM CONTAINING AN OPEN FIRE-PLACE.

is in place, also adds to the efficiency of the ventilation, as the air passes in through the space so formed.

A cheaper ventilator can be made by simply tacking a strip

of canvas, binders' board, or manilla paper, 20 to 25 centimetres wide, across the lower portion of the window-frame, and then raising the sash 10 to 15 centimetres. The air will pass in under the lower and between the lower and upper sashes and pass upward toward the ceiling and then gradually diffuse itself through the room. In summer a counter-opening may be obtained for the escape of foul air by lowering the upper sash, while in winter a stove or fire-place will furnish a good exit.

Fig. 8 shows the probable course of the air-currents in a room ventilated by means of a fresh-air inlet near the ceiling and an open fire-place. *A* is the inlet; *C* the fire-place; *G* the floor; *F*, ceiling; *E E*, flues.

B. Internal Wall-Coating.—A point of considerable importance in the outfitting of dwelling-houses is the material used for coating or decorating the inside of the walls. Green paint and green-colored wall-papers should be rejected. The reason for avoiding this color is the following: Bright-green pigments and dyes are largely composed of some compound of arsenic, which becomes detached from the wall or paper when dry, and, being inhaled, produces a train of symptoms which have been recognized as chronic arsenical poisoning. Many cases have been reported in which serious and even fatal poisoning has been produced in this way.[1] It would be advisable, therefore, to discard all bright-green tints in paints and ornamental paper-hangings.

C. Lighting.—Provision should be made in all dwelling-houses for an abundant supply of sunlight. Every room should have at least one window opening directly to the sun. It is not sufficient to give an ample window-space, which should be in the proportion of one to five or six of floor-space, but the immediate surroundings of the house must be taken into account. Thus, close proximity of other buildings, or of trees, may prevent sufficient light entering a room, although the window-

[1] Arsenic in Certain Green Colors, F. W. Draper. Third Annual Report Mass. State Board of Health, 1872, pp. 18-57.

space may be in excess of that required under ordinary circumstances.

Some form of artificial light will also be needed in all dwellings. Certain dangers are necessary accompaniments of all available methods of artificial illumination. The danger from fire is, of course, the most serious. This danger is probably least where candles are used, and greatest where the more volatile oils (kerosene, gasolene) are employed. The use of candles results in pollution of the air by carbon dioxide and other products of combustion to a greater degree than when other illuminating agents are used; they also give out a larger amount of heat in proportion to their power of illumination. Kerosene gives a good light when burned in a proper lamp, and is cheap, but the dangers from explosion and fire are considerable. The danger from explosion can be greatly reduced by always keeping the lamp filled nearly to the top, and never filling it near a light or fire. The danger of explosion is increased when the chimney of the lamp is broken, as then the temperature of the metal collar, by which the burner is fastened to the lamp, is rapidly raised[1] and the oil vaporized. If, at the same time, the lamp is only partially filled with oil, the space above it is occupied by an explosive mixture of air and the vapor of the oil. If this is heated to a sufficient degree an explosion will take place.[2]

The use of coal-gas is probably attended by less danger than the lighter oils, but by more than other means of illumination. In addition to the dangers from fire and explosions, which are inevitable accompaniments of defects in the fixtures, the escaping gas is itself exceedingly poisonous from the large amount of carbon monoxide it contains. It is, in fact, a very frequent occurrence in large cities that persons are killed by the inhalation of gas which has escaped from the fixtures or was

[1] H. B. Baker, in Report Mich. State Board of Health, 1876, p. 48.

[2] See an instructive paper by Prof. R. C. Kedzie, in Report Mich. State Board of Health for 1877, p. 71 *et seq.*

allowed to escape from the burner through ignorance. That variety of illuminating gas known as "water-gas" is more dangerous to inhale than coal-gas owing to the larger proportion of carbon monoxide contained in it. The "natural gas" used as a fuel and illuminant in some places in the United States is especially dangerous from the total absence of odor. The gas may escape in large quantity and fail to give notice of its presence except by an explosion, if ignited, or by producing asphyxia in those who incautiously venture into the air permeated by it.

The electric light (Edison's incandescent system) is probably open to less objection on the score of danger than any other of the illuminating systems mentioned. There is no trustworthy evidence that the electric light has any unfavorable influence on the vision, although Regnault supposed it would have a bad effect upon the ocular humors on account of the large proportion of the violet and ultra-violet rays it contained. In order to remove this objection Bouchardat advised the wearing of yellow glasses by those compelled to use this light for close work. The advantages of the incandescent light, besides the brilliant white light it gives, are that it is steady and does not produce any heat, nor does it pollute the air with carbon dioxide and other products of combustion. Professor von Pettenkofer has recently shown experimentally that the pollution of the air by the products of combustion is very much greater when gas is used than where the electric light is employed. The electric arc-lights are extremely dangerous on account of the high potential maintained in the wires, and the difficulty of thoroughly insulating the latter. Many deaths have occurred from this source, and, unless a method is discovered and adopted by which the voltage of the arc-light current can be greatly diminished without decreasing the efficiency of the light, this method of lighting must soon be given up in cities, owing to its danger, not only to those directly brought in contact with the conductors, but to others who may indirectly get in the way of the errant current.

In writing, sewing, reading, or other work requiring a constant use of accurate vision, the light, whether natural or artificial, should fall upon the object from above and on the left side. Hence, windows and burners should be at least at the height of the shoulder and to the left of the person using the light.

Increased ventilation facilities must be provided where artificial light (except the electric light) is used to any extent. It has been calculated that for every lighted gas-burner 12 to 15 cubic metres of fresh air per hour must be furnished in addition to the amount ordinarily required in order to maintain the air of the room at the standard of purity.

V.—WATER-SUPPLY.

The water-supply of a dwelling-house should be plentiful for all requirements, and its distribution should be so arranged that the supply for every room is easily accessible. Where practicable, water-taps should be placed on every floor, both for convenience and for greater safety in case of fire. It is also a result of observation that personal habits of cleanliness increase in a direct ratio with the ease of obtaining the cleansing agent. The inmates of a house where water is obtainable with little exertion are much more likely to be cleanly in habits than where the water-supply is deficient or not readily procured.

VI.—HOUSE-DRAINAGE.

Provision must be made for the rapid and thorough removal of waste-water and excrementitious substances from the house. This is most easily and completely accomplished by well-constructed water-closets and sinks. Water-closets should, however, not be tolerated in any room occupied as a living- or bed- room. It would doubtless be very much more in accordance with sanitary requirements to have all permanent water-fixtures, water-closets, and bathing arrangements placed in an annex to the dwelling proper. In this way the most serious danger from water-closets and all arrangements having a connection with a

cess-pool or common sewer—permeation of the house by sewer-air—could be avoided.

Water-closets, however, presuppose an abundant supply of water. Unless this can be obtained and rendered available for flushing the closets, soil-pipe, and house-drain, the dry-earth or pail system should be adopted. Privies should not be countenanced. Experience in several large cities of Europe has demonstrated[1] that the pail system can be adopted with advantage and satisfactorily managed even in large communities.

As house-drainage may be considered the first and most important link in a good sewerage system, a brief description will be here given of the details of the drainage arrangements of a dwelling-house. The rapid and complete removal of all fæcal and urinary discharges, lavatory- and bath- wastes, and kitchen-slops must be provided for. For these purposes are needed, *first*, water-closets and urinals, wash-basins and bath-tubs, and kitchen- or slop- sinks; *second*, a perpendicular pipe, with which the foregoing are connected, termed the soil-pipe; and, *third*, a horizontal pipe, or house-drain, connecting with the common cess-pool or sewer.

A. Water-Closets.—There are five classes of water-closets in general use. They are the pan-, valve-, plunger-, hopper-, and washout- closets.

Pan-closets are those found in most old houses containing water-closet fixtures. Just under the bowl of the closet is a shallow pan containing a little water, in which the dejections are received. On raising the handle of the closet, the pan is tilted and the water at the same time is turned on, which washes out the excrement and sends it into or through the trap between the closet and the soil-pipe. It will be readily understood that the space required for the movement of the pan—the "container," as it is termed—is rarely thoroughly cleansed by the passage of water through it. Fæcal matter, paper, etc., gradually accumulate in the corners of the container, and, as a consequence, pan-

[1] See Chapter v, p. 139.

closets are always, after a brief period of use, foul. There are other defects in the construction of the pan-closet which render it untrustworthy, but the one especially pointed out—the impossibility of keeping it clean—is enough to absolutely condemn its use, from a sanitary point of view. It is decidedly the worst form of closet that can be used.

Valve-closets are merely modifications of the pan-closet. The bottom of the bowl is closed by a flat valve, which is held in its place by a weight. By moving a lever the valve is turned down, allowing the excreta to drop into the container. The only differences between the pan- and valve- closets are that in the latter a flat valve is substituted for the pan of the former, and that this allows the container to be made smaller. Otherwise, there are no advantages in the valve-closet. Considered from a sanitary stand-point, the valve-closet is no worse than the pan-closet, and but very little, if any, better.

The third variety, or plunger-closet, has several marked advantages over the two just described. The characteristic feature of the closets of this class is that the outlet, which is generally on one side of the bowl, is closed by a plunger. This bowl is always from one-third to one-half full of water, into which the excreta fall. On raising the plunger, the entire contents of the bowl are rapidly swept out of the apparatus into the soil-pipe, the bowl thoroughly washed out by a sudden discharge of water, and, on closing the outlet with the plunger, the bowl is again partly filled with water. An overflow attachment prevents accumulation of too large a quantity of water in the bowl. This overflow, however, sometimes becomes very foul and objectionable. The Jennings, Demarest, and Hygeia are types of this class. The principal objection is that the plunger sometimes fails to properly close the outlet, allowing the water to drain out of the bowl, and thus destroying one of its principal advantages. The mechanism is also somewhat complicated and likely to get out of order.

The hopper-closet consists of a deep earthenware or enameled

iron bowl, with a water-seal trap directly underneath. The excreta are received directly into the proximal end of the trap, and when the water is turned on the sides of the bowl are washed clean and everything in the bowl and trap swept directly into the soil-pipe. There is no complicated mechanism to get out of order, the trap is always in sight, and the entire apparatus can always be kept clean and inoffensive, as there are no hidden corners or angles for filth to lodge. This form of closet is, all things considered, one of the best for general use.

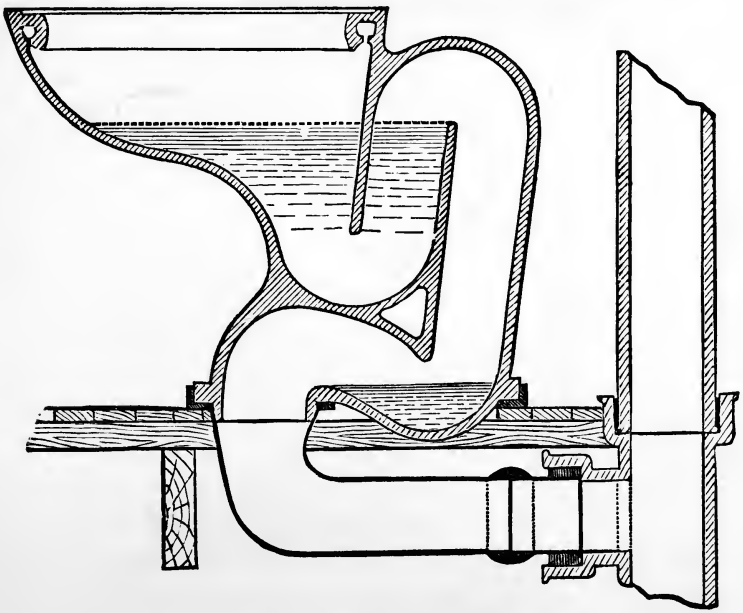

FIG. 9.—THE "DECECO" CLOSET. (New Form.)

The "wash-out" closets are of various shapes, some having the trap in the bowl itself, others having a double water-trap. They are generally simple in construction, and not likely to get out of order. They do not present any decided advantages over the simple hopper, although at the present time they are more used than any other form of closet. Of the recent improvements in this form of closet may be mentioned the "A. G. M.,"[1] shown

[1] Manufactured by the Myers Sanitary Depot, New York.

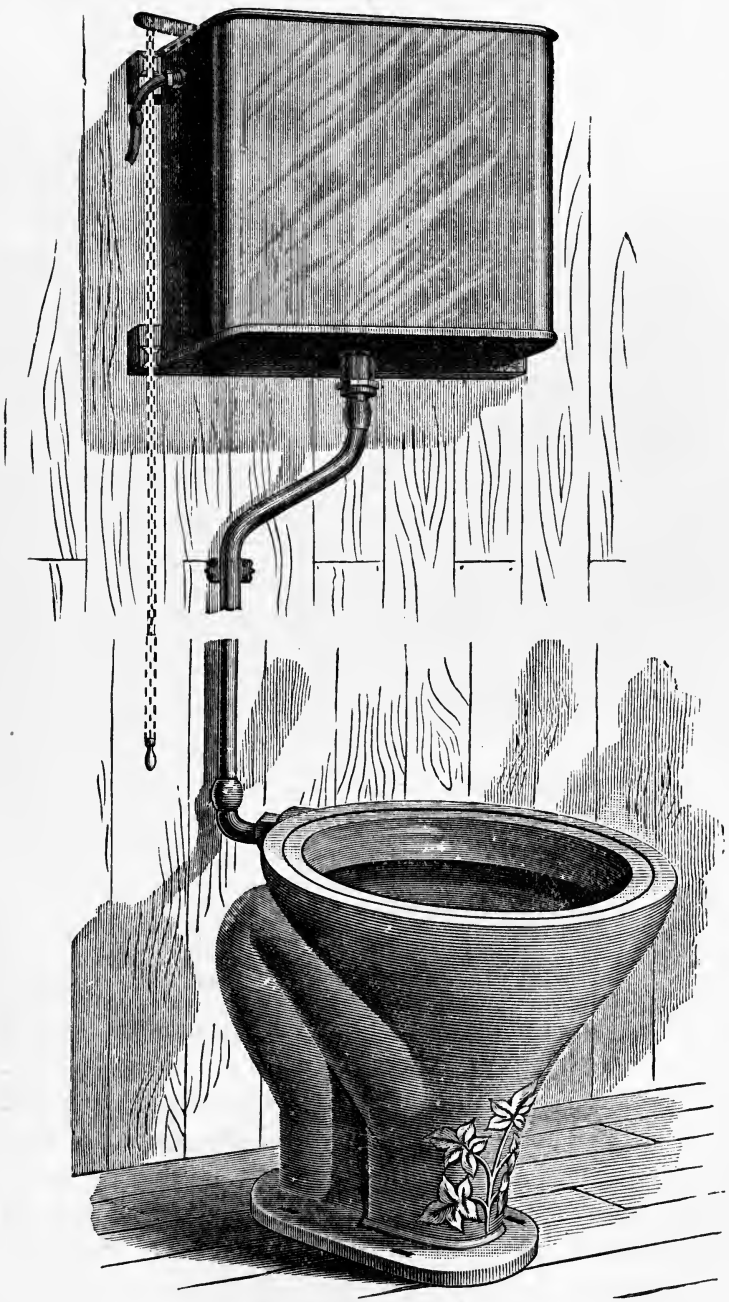

FIG. 10.—THE "A. G. M." CLOSET.

in view with cistern in Fig. 10, and in section in Fig. 11, and the "Dececo," Fig. 9, invented by Col. George E. Waring. In the latter the automatic siphon principle, so ingeniously used by Rogers Field in the construction of the automatic flush-tank, is applied to the scouring of a water-closet. Practical experience for six or seven years has demonstrated the great usefulness of this closet. If the delivery of water from the flushing-cistern is properly regulated, at first rapid to thoroughly wash out the

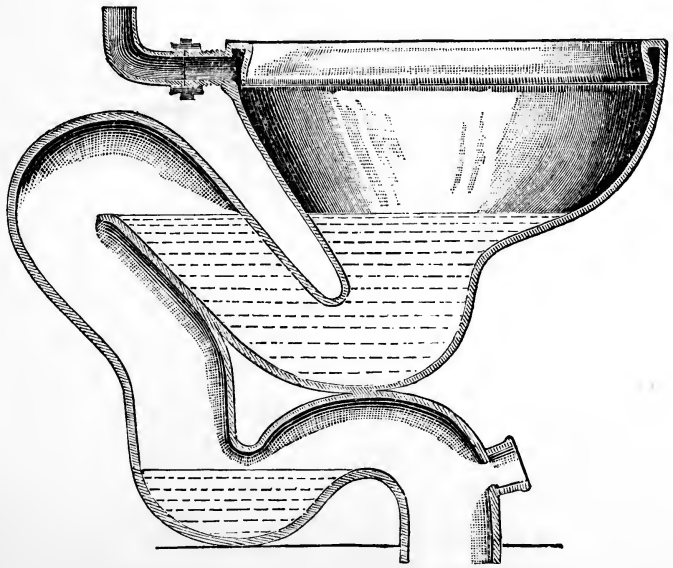

FIG. 11.—SECTIONAL VIEW OF "A. G. M." CLOSET.

closet and connections, and then slow to re-establish the proper depth of seal in the trap, the closet should be thoroughly satisfactory in its working.

Water-closets should not be inclosed in wooden casings, as is almost universally done. Everything connected with the closet, soil- and drain- pipes, water-supply, and all joints and fixtures should be exposed to view so that the defects can be immediately seen and easily corrected. By laying the floor and back of the closet in tiles or cement, such an arrangement can even

be made ornamental, as suggested by Waring;[1] who says that a closet "made of white earthenware, and standing as a white vase in a floor of white tiles, the back and side walls being similarly tiled, there being no mechanism of any kind under the seat, is not only most cleanly and attractive in appearance, but entirely open to inspection and ventilation. The seat for this closet is simply a well-finished hard-wood board, resting on cleats a little higher than the top of the vase, and hinged so that it may be conveniently turned up, exposing the closet for thorough cleansing, or for use as a urinal or slop-hopper."

Where the arrangement here described is adopted, extra urinals are unnecessary and undesirable. Where they are used they should be constantly and freely flushed with water, otherwise they become very offensive. The floor of the urinal should be either of tiling or enameled iron.

B. Water-Supply for Closets.—The water-supply for flushing water-closets should not be taken directly from the common house-water supply, but each closet should have an independent cistern large enough to hold a sufficient quantity of water for a thorough flushing (20 to 30 litres) every time the closet is used. The objections to connecting the water-closet directly with the common house-supply are, that there is often too little head of water to properly flush the basin; and, secondly, if the water be drawn from a fixture in the lower part of the house, while the valve of a water-closet in an upper floor is open at the same time, the water will not flow in the latter (unless the supply-pipe is very large), but the foul air from the closet will enter the water-pipe, and may thus produce dangerous fouling of the drinking-water. Hence, separate cisterns for each water-closet should always be insisted upon.

The arrangement of these cisterns is often difficult to comprehend. Fig. 12 shows the interior arrangement of one form. The ball-shaped float, *a*, cuts off the supply when the tank is full, while opening the valve, *b*, by means of the crank, *c*, dis-

[1] Sanitary Condition of New York City, Scribner's Monthly, vol. xxii, No 2, June, 1881.

charges the water. The rounded annex, *d*, contains enough water to partly fill the closet-bowl and trap after the contents have been washed out by the rapid flush.

C. Traps.—Every water-closet, urinal, wash-basin, bath-tub, and kitchen-sink should have an appropriate trap between the fixture and the soil-pipe. The trap should be placed as near the fixture as practicable, as pointed out above; in the best forms of water-closet the bottom of the closet itself forms part of the trap.

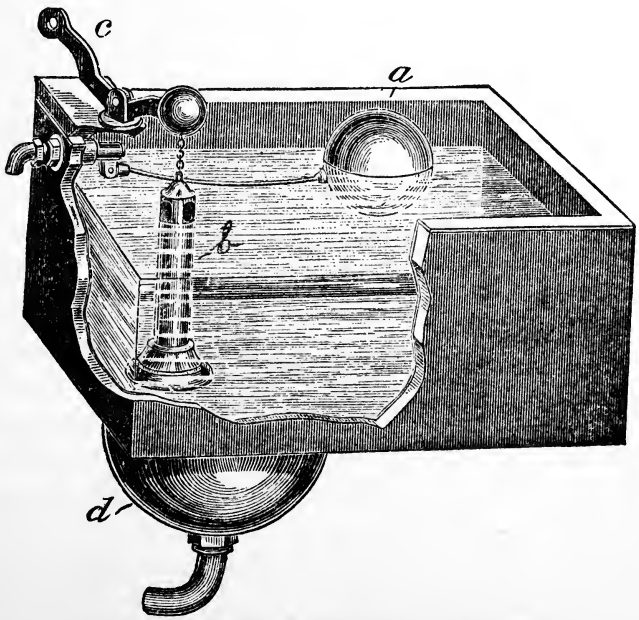

FIG. 12.—FLUSHING CISTERN FOR WATER-CLOSETS.

Traps differ in shape and mechanism. The simplest and usually efficient is the ordinary S-trap (Fig. 13). This trap is of uniform diameter throughout, and has no angles for the lodgment of filth. A free flush of water cleanses it perfectly, and it rarely fails to furnish a sufficient obstruction to the passage of sewer-air from the soil-pipe, unless the water has evaporated, or been forced out under a back-pressure of air in the soil-pipe, or been siphoned out, and thus the seal broken.

The D-trap and bottle-trap are objectionable on account of the great liability of becoming fouled by filth lodging in the corners, while in the mechanical traps, like Bowers' ball-valve trap, Cudell's trap, and others of this class, there is always danger of insufficient seal by filth adhering to the valve, and thus preventing its exact closure.

Most of the traps now furnished by the dealers in plumbers' supplies have an opening in the highest part for attaching a vent-pipe. It has been found that the seal in most traps can be broken by siphonage, if the pressure of air on the distal side (the side toward the soil-pipe) of the trap is diminished, or, on the other hand, by increase of pressure in the soil-pipe the water in the trap may be forced back into the fixture, and thus sewer-air enter the room. By providing for a free entrance and exit of air to the trap this breaking of the seal can be prevented. The ventilation of traps is, however, an evil, as it furnishes an additional means of evaporation, and when the fixture is not in frequent (daily) use the seal is sooner broken. The elaborate extra system of ventilation of traps, so generally insisted upon by plumbers and sanitary engineers, is unnecessary. If the soil-pipe is of the proper size and height, siphonage of traps will not be likely to occur. The waste-pipe connecting the fixture and the soil-pipe should be as short as possible; in other words, all water-closets, urinals, baths, and lavatories should be placed as near the soil-pipe as practicable, in order to have no long reaches of foul waste-pipe under floors or in rooms.

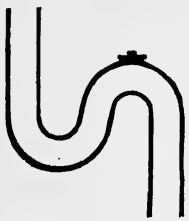

FIG. 13.—S-TRAP.

Dr. E. S. McClellan has recently invented a trap which obviates many of the objections urged against all previous devices, and is intended to meet the defects of the S and other traps. It consists of a body containing a light, inverted cup, with its edges resting in an annular groove containing mercury, which forms an absolute seal against the escape of sewer-air. When

a slight diminution of pressure occurs on the sewer side of the cup, the greater external pressure lifts the cup out of the mercury and permits a free inflow of air until the wonted equilibrium is re-established, when the cup drops back into the mercury by gravity, and effectually closes the trap against any outflow. With this trap siphonage of the seal is impossible. Fig. 14 shows this trap with the cup down, and Fig. 15 with the cup raised, allowing inflow of air.

For an ordinary wash-bowl or bath-waste (which should

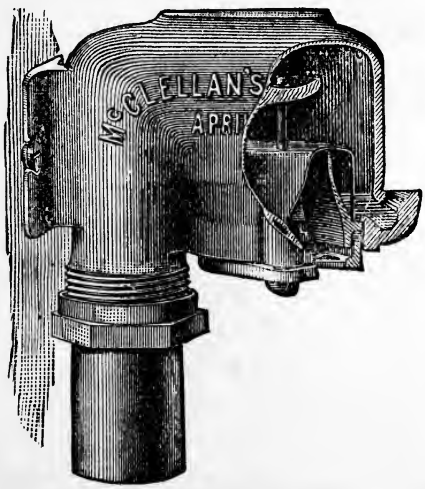

FIG. 14.—SECTIONAL VIEW OF VENT, WITH CUP IN NORMAL POSITION.

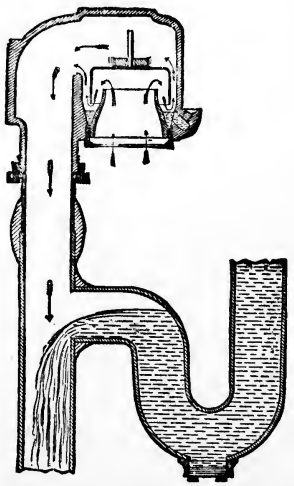

FIG. 15.—SECTIONAL VIEW OF VENT, WITH CUP LIFTED OUT OF THE MERCURY BY THE INFLOWING CURRENT OF AIR INDICATED BY THE ARROWS.

always be trapped), the Connolly globe-trap, shown in Figs. 16 and 17, is an excellent fixture. It is impossible, under ordinary circumstances, to break the seal by siphonage.

D. The Soil-Pipe.—The vertical pipe connecting the water-closets and other fixtures with the house-drain is called the soil-pipe. It should be of iron, securely jointed, of an equal diameter (usually 10 centimetres) throughout, and extend from the house-drain to from 1½ to 2 metres above the highest point of the house. The connections of all the waste-pipes from water-closets, baths, etc., should be at an acute angle, in order

that an inflow at or nearly at right angles may not produce an obstruction in the free passage of air up and down the soil-pipe. The diameter of the soil-pipe, at its free upper end, should not be narrowed; in fact, according to Col. Geo. E. Waring, the up-draught is rendered more decided if the upper extremity of the soil-pipe is widened.[1] The internal surface of the pipe should be smooth, and especial care should be taken to prevent projections inward at the joints; otherwise, paper and other

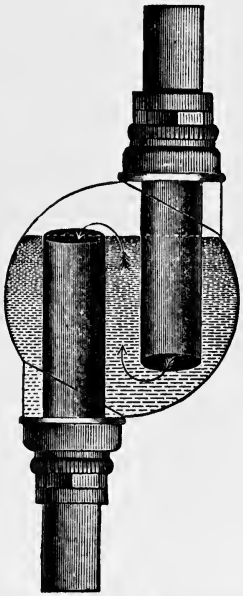

FIG. 16.—CONNOLLY GLOBE-TRAP.

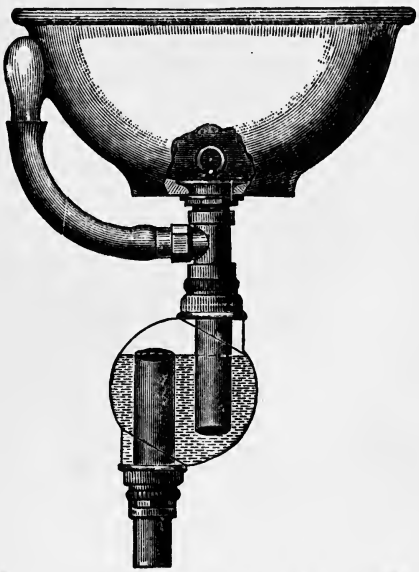

FIG. 17.—GLOBE-TRAP ATTACHED TO BASIN.

matters will adhere to the projections, and gradually obstruct the pipe.

E. The House-Drain.—The horizontal or slightly inclined pipe which connects the lower end of the soil-pipe with the sewer or cess-pool, the point of final discharge from the house, should be of the same diameter and material as the soil-pipe. The joints should be made with equal care, and the pipe should be exposed to view throughout while within the house-walls.

[1] Am. Architect, p. 124, Sept. 15, 1883.

If sunk below the floor of the cellar it should be laid in a covered trench, so that it may be readily inspected. The junction between the vertical and horizontal pipe should not be at a right angle, but the angle should be rounded. The drain-pipe should not be trapped. This is contrary to the advice of sanitary authorities generally, but the author thinks it unadvisable to trap the drain-pipe. There should be no obstruction to the outflow of sewage from the house, and a trap in the drain-pipe is of no avail against the passage of sewer-air from the sewer or cess-pool into the soil-pipe, if the pressure of the air in the former is increased. Furthermore, if the passage of air backward and forward between the sewer and the external air at a sufficient height (above the roofs of houses, for example) is free and unobstructed, the sewers (or the cess-pool, as the case may be) will be better ventilated than if an obstruction to such free circulation, in the form of a trap, be placed in the drain-pipe.

Nearly all sanitary authorities direct that an opening for the admission of fresh air—"fresh-air inlet"—should be made in the drain-pipe, before its connection with the sewer or cess-pool. This is done with the view of having a constant current of fresh air entering near the base of the soil-pipe and passing upward through it. Theoretically the current ought always to pass in this direction. Practically, however, the current is found, at times, to pass the other way, and the foul air from the soil-pipe may be discharged into the air near the ground, where it would be much more likely to do harm than when discharged high up in the air beyond the possibility of being breathed.

OFFICIAL SUPERVISION OF THE SANITARY ARRANGEMENTS OF DWELLINGS.

In most cities and towns the municipal authorities have provided for an official inspection of buildings, to prevent neglect of precautions against fire and other manifest dangers to life. It is only very recently, however, that the authorities of some of the larger cities in this country have enacted laws to prevent

improper construction of house-drainage works. Although none of these laws or ordinances cover the subject completely, yet their proper enforcement must result in great advantage.

Within the past few years, following the example of Edinburgh, volunteer associations have been organized in various cities of this country, with the object of securing constant expert inspection and supervision of the drainage arrangements of dwellings and other necessary sanitary improvements.

The good results accomplished by the Newport Sanitary Protection Society, the New Orleans Auxiliary Sanitary Association, and other similar bodies attest the usefulness of such organizations.

[The following works are recommended to the student who desires a fuller knowledge on the subjects treated in this chapter:—

W. H. Corfield, Dwelling-Houses, Their Sanitary Construction and Arrangements, N. Y., 1880.—Wm. Paul Gerhard, House-Drainage and Sanitary Plumbing, Fourth Report State Board of Health of R. I., 1881.—Eliot C. Clarke, Common Defects in House-Drains, Tenth Annual Report Mass. State Board of Health, 1879.]

CHAPTER VII.

Construction of Hospitals.

SITE.

If the choice of a site for the habitations of healthy persons is a matter of vital importance, as was pointed out in the last chapter, it needs no argument to impress upon the reader the actual necessity of choosing a site with wholesome surroundings for a habitation for the sick. In selecting a site for a hospital, therefore, it is of prime importance to avoid a location where unsanitary influences prevail.

While a hospital should always be easily accessible, it is not desirable that it should be in a noisy or crowded part of a city. Where a hospital is primarily designed for the reception of accident or "emergency" cases, it is, of course, necessary to have it near to where accidents are likely to occur. In a city this will probably be in the most crowded and noisy part.

The direction of the prevailing winds from the city should be avoided in selecting a site for a hospital.

Free admission of sunlight and air must be secured to all parts of the hospital. An elevated location is therefore desirable, although exposure to violent winds must, if possible, be avoided.

The soil upon which a hospital is built should be clean, easily drained, with a deep-ground water-level, not liable to sudden oscillations. The neighborhood of a marshy or known malarious region should be avoided.

THE BUILDINGS.

The building area must be large enough to permit the construction of buildings in accordance with the modern recognized principles of hospital construction. Overcrowding is not

permissible, either of the grounds by buildings or of the buildings by patients.

Having determined the number of patients for whom provision is to be made and the character of the diseases to be treated, an estimate must be made of the area necessary for a hospital. Taking into account all the buildings needed, the area required will be—for two or more storied buildings—not less than 30 square metres per bed. If one-story buildings are to be erected more space will be required, and if infectious diseases are to be treated in the hospital the above space-allowance must be doubled or trebled. In the new Johns Hopkins Hospital, in Baltimore, the area occupied by the buildings is 56,000 square metres, and provision is to be made for 300 patients. This, covering, of course, the area occupied by the administration building, nurses' home, kitchen, dispensary, operating and autopsy theatre, laundry, etc., gives an area of 187 square metres per bed. The actual allowance of floor space per bed is $11\frac{1}{2}$ square metres; for patients with infectious diseases the space-allowance is nearly treble, being 29 square metres.

Within recent years the principles of hospital construction have undergone considerable modification. While formerly a large hospital consisted usually of one large, two or more storied building, in which all the various departments were comprised under one roof, the aim has recently been to scatter the wards as much as practicable consistent with reasonable ease of supervision and administration. Under the former plan, with large wards connected by common corridors and stairways, ease of administration was primarily secured; in the latter, the most important object of a hospital, "a place for the sick to get well in," is more nearly attained. While many hospitals are still being constructed on the old plan, of a single block of several stories in height, nearly all sanitary authorities are agreed that the plan of separate pavilions of one or, at most, two stories, in which the buildings are entirely disconnected, or connected only by means of an open corridor for convenience of

administration, is best for the patients, and, leaving out of account the cost of the ground, is also the most economical.

The recent development of the pavilion system of hospitals may be attributed largely to the success obtained in treating the sick and wounded in the simple barrack hospitals during the late war between the States. The army barrack hospital is the original type of the pavilion hospital of the present day.

Each pavilion consists of one or two wards, containing from ten to thirty beds altogether. In each pavilion or ward is also a bath- and wash- room, water-closet, dining-room, scullery, attendants' room, and sometimes a day-room for patients able to be out of bed.

The two-story pavilion is built on the same plan, and is generally adopted in cities, or where economy of space is desirable for financial reasons, and where no infectious diseases are treated. Where practicable, one-story pavilions should always be adopted, as they are more easily heated, ventilated, and served than two-storied buildings.

When a number of pavilions or wards are connected by a corridor with each other, and with a central or administration building and other service buildings, the aggregation constitutes a modern pavilion block-hospital. The Johns Hopkins Hospital, already referred to, is a model hospital of this class, and its plans should be studied in detail by all who are more particularly interested in hospital construction. The general wards are in one- and two- story buildings, connected by a corridor with each other and with the administration and service buildings. In addition to two buildings containing private rooms and small wards for patients able to pay for the extra accommodations, there is a line of pavilions running from east to west. The corridor cuts all the pavilions near the north ends of the buildings, separating the ward almost entirely from the service part of the building. This arrangement leaves the south, east, and west fronts of the wards entirely exposed to the sun's rays,—a very important advantage. The kitchen and laundry are at

opposite angles of the grounds, while the autopsy building is placed in the extreme northeast corner of the grounds, as far from all the wards as practicable.

The free space between the separate pavilions should be at

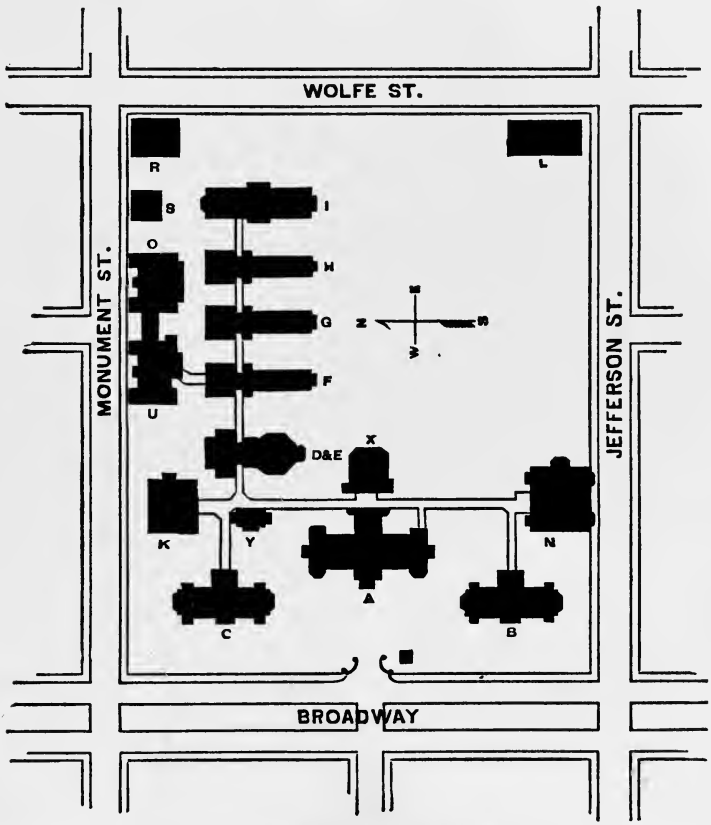

FIG. 18.—PLAN OF JOHNS HOPKINS HOSPITAL.

A. Administration Building. B. Female Pay-Ward. C. Male Pay-Ward. D. Male Surgical Ward. E. Female Surgical Ward. F. Male Medical Ward. G. Female Medical Ward. H. Gynæcological Ward. I. Isolating Ward. K. Kitchen. L. Laundry. N. Nurses' Home. O. Dispensary. R. Pathological Building. S. Stable. U. Amphitheatre. X. Apothecary's Building. Y. Bath-House.

least twice the height of the building. In the Johns Hopkins Hospital, the space is 18 metres between the one-story common wards, which are 11 metres in height from the surface of the ground to the ridge of the roof.

VENTILATION AND HEATING.

The cubic space (initial air-space) per bed in the wards should not be less than 1500 to 2000 cubic feet (42 to 56 cubic metres), and for surgical or lying-in cases and contagious diseases, 70 cubic metres should be allowed. The ventilating arrangements should secure an entire change of the air two to three times in an hour.

In most sections of the United States, natural ventilation can be relied on to keep the air in hospital wards pure (assuming, of course, the proper construction of the buildings). The windows, doors, and walls are important factors in securing this ventilation. Hence, especial care is to be paid to their construction and arrangement.

Many German, French, and English authorities on hospital building urge the importance of making the walls impervious by cement, glass, or paint. The peculiar odor known as "hospital odor," it is asserted, cannot be prevented in any hospital in which the floors, walls, and ceilings are not absolutely impervious. The American practice is generally in favor of walls which permit transpiration of air. In the experience of the author the imperviousness of the walls is not necessary to secure freedom from hospital odor. It remains a question for serious consideration whether the diminution of natural ventilation would not counterbalance any good resulting from non-absorptive walls.

The interior of the walls should be perfectly smooth and plain; no projections, cornices, or offsets of any kind are permissible. The desirability of this restriction was clearly expressed nearly a hundred years ago by John Howard: "From a regard to the health of the patients, I wish to see plain, white walls in hospitals, and no article of ornamental furniture introduced."[1]

Windows should run quite to the ceiling, and should not be arched, but finished square at the top. There should be one

[1] An Account of the Principal Lazarettos of Europe, etc., p. 57. London, 1791.

window for every two beds. The window-sash should be double to retain heat, and the lights heavy, clear glass. Ventilation can be promoted by raising the outer sash from below and lowering the inner one from above. The insertion of a Sherringham ventilator at the top of the inner sash will aid in giving the incoming air-current an upward direction.

Heating is best accomplished by introducing hot air from without, or by stoves or fire-places in the centre of the wards. Where hot air is introduced from without, it should be heated by passing it over steam- or hot- water coils, and not by passing it through a furnace, which may produce super-heating and excessive dryness of the air.

In a series of experiments by Dr. Edward Cowles at the Boston City Hospital,[1] the air was heated to 32° by passing it over steam-coils. It was admitted to the wards by numerous inlets 30 centimetres square. The best velocity for ventilating and warming purposes was found to be 54 metres per minute. Exit openings were in the ceiling, and it was found best to make them large, as by this means the rapidity of exit currents is reduced.

Where the warming of the ward must be accomplished by stoves or fire-places in the ward, the best plan, for square and octagon wards, is to have a large central chimney with arrangements on the four sides for fire-places or stoves. This chimney can also be used as a very efficient ventilating shaft throughout the year by a device put in practice by Mr. John R. Neirnsee, architect of the Johns Hopkins Hospital.[2] In oblong wards, two or more large stoves, placed at equal distances along the centre of the wards, will heat the wards effectually.

Floors should be made of tiles, slate, or oak or yellow-pine lumber. If wood is used, it should be well seasoned, perfectly smooth, and all joints accurately made. The floor should be kept constantly waxed to render it impervious to fluids.

[1] Report of the Massachusetts State Board of Health for 1879, pp. 231-248.

[2] Hospital Construction and Organization: Plans for Johns Hopkins Hospital, p. 335 *et seq.* New York, 1875.

The space between the floor and ceiling below should be filled with some fire-proof non-conducting material, such as cement or hollow bricks, in order to isolate each floor or ward as much as possible from others, both to prevent transmission of noise and extension of fire.

All corners and angles on the inside of the building should be rounded to facilitate the removal of dust.

In cleaning up, care should be taken not to stir up the layers of dust too much by active sweeping or dusting. The floors, furniture, door- and window- casings should be wiped off with damp cloths. Soiled bedding, clothing, dressings, and bandages must be promptly removed from the ward. Mattresses and other bed-clothing should not be shaken in the ward.[1]

Water-closets or (where the dry method of removal of excreta is in use) earth- or pail- closets should be placed where they can be easily reached by the patients, but the apartment in which they are placed must not open directly into the ward. The entrance to this apartment should be from the corridor or, better still, from the open air. The ventilation of water-closets should be independent of and entirely distinct from that of the ward or other part of the hospital building.

It is, of course, unnecessary to more than call attention to the vital importance of the prompt removal of all excreta, both solid and liquid, from the ward or hospital building. To attempt disinfection of excreta and allow them to remain in the ward after being voided is a pernicious practice, which should under no circumstances be permitted. All utensils for the reception of excreta, bed-pans, etc., should be immediately emptied and thoroughly cleansed.

Urinals are not advisable; the simple hopper-closet with hinged, hard-wood seat, as described in Chapter VI, is sufficient.

A bath-room and lavatory should be attached to every ward. It should be placed in the service building, and be

[1] A Wernich: Ueber Verdorbene Luft in Krankenræumen. Volkmann's Samml. Klin. Vortr., No. 179, p. 24.

easily accessible to the patients. There should also be portable bath-tubs in order that baths may be given in the wards when necessary.

Every large general hospital should also have a special apartment or building where baths of various kinds, such as medicated, vapor, Turkish, and Russian baths, could be given. In lying-in hospitals, special arrangements for giving vaginal and uterine douches must also be furnished.

A daily water-supply of at least 450 litres per bed should be provided. The water should be easily accessible from the wards and various parts of the service building.

All water-closets, soil- and waste- pipes must be properly trapped; all joints must be properly made and all sewer connections made on the most improved plans. All work of this sort should be properly tested before being accepted, and frequently inspected afterward.

No sewer or house-drain should be laid under a ward.

A disinfecting chest for disinfecting soiled clothing, bedding, dressings, etc., should be placed in the basement of the ward, and connected with the latter by an iron chute, closing perfectly by an iron top. The best and most convenient disinfectant is steam. This is also the best means to destroy vermin in clothing and bedding.

It is questionable whether a nurse's room should be attached to a hospital ward. The nurse's place, when on duty, is in the ward itself, not in a room separate from it. Where there is a nurse's room, it should not be furnished with sleeping arrangements, for this is a strong temptation to neglect of duty on the part of the nurse. A nurse not on duty should not be permitted to remain about the ward.

A ward-kitchen should be in the service building, where articles of food can be kept hot or cold when necessary, and where special dressings, cataplasms, hot water, etc., can be prepared. A small gas-stove only should be allowed in the ward-kitchen, as the regular meals of the patients are prepared in the

central kitchen, which should be totally detached from the hospital. The ward-kitchen can be easily utilized as a nurse's room, and in a small hospital can also be used as a store-room for the patients' body- and bed- linen and clothing.

The dining-room for patients able to be out of bed should be in the service building. A room with a good light and well ventilated and heated should be selected for this purpose. In the intervals between meals this room could be used as a day-room for such patients as should be out of bed, but who are not able to be in the open air.

A dead-house, containing a dead-room, autopsy-room, and a room fitted up for rough microscopic and possibly photographic work, is a necessity to every well-appointed general hospital. The dead-house should be entirely separate from the ward buildings.

The kitchen should be separate from the other buildings, and in large hospitals should also be the central station for the heating arrangements, if hot water or steam are to be used. The laundry may be connected with it. The kitchen should be connected with the wards by means of a covered corridor to avoid exposure in carrying the food to the wards.

The administration building should contain office-rooms for the superintendent and resident physician, pharmacy, library, reception-rooms for visitors, living-rooms for one or more assistants, and dwellings for the superintendent and resident physician.

THE ADMINISTRATION AND MANAGEMENT OF A GENERAL HOSPITAL.

The general management of a hospital should be under the direction of a superintendent, who, besides being a medical man, should be especially qualified by study and experience for the work. The superintendent of a large hospital should not be expected to perform any of the routine professional work in the wards, but he should be responsible for the service, both professional and lay, in the hospital. He should be the financial officer, and in all other things concerning the hospital his

judgment should decide. He should have sufficient assistance to permit all necessary duties to be promptly performed. For this purpose he should have a secretary, or clerk, who should not be a medical man; otherwise the attention of the latter might be withdrawn from his clerical duties to the more interesting professional work in the hospital. The plan advocated by some authorities, to have two superintendents for large hospitals,—one of whom shall be a medical man and direct only the professional work of the hospital, while the other shall have charge of the administrative functions,—does not commend itself to the author. It involves a division of responsibility which will, in nearly all cases, eventually lead to differences of opinion likely to prove unfavorable to the best interests of the hospital.

It is customary in this country to appoint as resident physicians and surgeons in hospitals, recent graduates, whose functions are usually limited to carrying out the directions of the visiting physicians and surgeons, and sometimes to act on their own responsibility in emergencies. This system has some advantages for the physicians, but is usually detrimental to the best interests of the patients. The resident medical officer in a large hospital should always be a thoroughly qualified, experienced physician, capable of deciding promptly when the occasion arises, and he should be responsible to the superintendent for the proper performance of his professional duties. Necessarily, a physician with the qualifications indicated, would demand a very much larger salary than is usually paid resident physicians, but it should be understood that no hospital in which the good of the patient is the first consideration can be conducted on a cheap basis.

Visiting physicians and surgeons and all resident medical officers should be chosen with reference to their general and special qualifications for the duties expected of them. It would seem to be a good plan to make the selections for subordinate positions, at least, by competitive examination.

The sick in a hospital should be properly classified. Male

and female patients should, of course, be treated in separate wards. A primary classification into medical, surgical, and obstetrical cases or wards is also indicated. Infectious diseases, such as typhoid fever, erysipelas, cholera, yellow fever, croupous pneumonia, etc., should not be treated in the same wards with rheumatism, Bright's disease, cardiac and nervous disorders, or simple digestive derangements. It is questionable, however, whether it is advisable to make a very elaborate classification of the various diseases except in very large hospitals.

An accurate record, made at the time of observation, and not written from memory afterward, should be kept of the history and progress of every case. The record should show not merely the symptoms and diagnosis, but the medical and hygienic treatment. In most hospitals where such records are kept the entries are made either in a simple memorandum-book or in a more or less complicated case-record. A simple form of case-record has been devised by Surgeon Walter Wyman, United States Marine Hospital Service, which seems to possess advantages that render its general adoption desirable.

The following convenient form of record for obstetric cases is used in the Maryland Maternité under direction of the author:—

TABLE XIX.

OBSTETRIC CASE-RECORD OF MARYLAND MATERNITÉ.

Name . . . . .
Date of Admission . . . . .
Registered No. . . . . Confinement No. . . . . .
Labor began, Date . . . . . Hour. . . . . Minute . . . . .
Date of Delivery . . . . . Hour . . . . . Minute
Previous Confinements . . . . . .

EXTERNAL MEASUREMENTS OF PELVIS.

Between Anterior S. S. Processes . . . . . .
Between Widest Part of Iliac Crests . . . . . .
External Conjugate Diameter . . . . . .

DURATION OF LABOR AND CHARACTER OF PAINS.

1st Stage . . . . . Hours . . . . . Minutes . . . . . .
2d Stage . . . . . Hours . . . . . Minutes . . . . . .
3d Stage . . . . . Hours . . . . . Minutes . . . . . .

Rupture of Membranes . . . . . Hour . . . . . Minute
Maternal Pulse During Pains . . . . . Between Pains. . . . . .
Drugs Used . . . . . Quantity . . . . . When . . . . . .
Operations Performed . . . . . .
Pelvis . . . . . Cervix. . . . . Perinæum . . . . . .
Date of Beginning Milk Flow. . . . . .
Pulse and Temperature for Same Date. . . . . For Previous Day. . . . . .
Method of Delivery of Placenta . . . . . .
Position when Delivered . . . . . .
Weight . . . . . Length . . . . . .
Breadth . . . . . Thickness . . . . . .
Shape . . . . . .
Time of Tying Cord . . . . . Length . . . . . .
Spiral . . . . . Point of Insertion . . . . . .
Knots . . . . . Varicosities . . . . . .

	Urine Before Labor.	1st Day After Labor.	8th Day After Labor.
Specific Gravity			
Reaction			
Albumen, per cent			
Sugar			
Chlorides			

PULSE AND TEMPERATURE.

	9 A.M.		7 P.M.		
1st day					
2d "					
3d "					
4th "					
5th "					
6th "					
7th "					
8th "					
9th "					
10th "					

CHILD.

Presentation and Position . . . . . Sex . . . . . .
Fœtal Heart Between Pains . . . . . During Pains . . . . . .
Caput Succedaneum . . . . . Respiration . . . . . .
Circulation. . . . . Temperature. . . . . .
Weight at Birth . . . . . 3d Day. . . . . 6th Day . . . . . .
Method of Feeding. . . . . .

MEASUREMENTS.

Length at Birth . . . . . Length 4th Day . . . . . .

DIAMETERS.

	At Birth.	4th Day.
Occipito-Frontal.		
Occipito-Mental.		
Suboccipito-Bregmatic		
Biparietal.		

CIRCUMFERENCES.

	At Birth.	4th Day.
Occipito-Frontal		
Suboccipito-Bregmatic		
Shoulders.		
Hips		

Discharged . . . . . .
Name of Nurse . . . . . .

In hospitals where cases of surgical diseases and injuries are received, a special apartment should be fitted up as an operating room. Operations should not be performed in a ward in the presence of other patients.

[The following works are recommended for additional study upon this subject:—

Hospital Construction and Organization; New York, 1875 (especially the essays of Drs. Billings, Folsom, and Stephen Smith).—Krankenanstalten, by L. Degen, in V. Pettenkofer und Ziemssen's Handbuch der Hygiene.—Spital, by C. Böhm, in Realencyclopädie d. ges. Heilkunde, Bd. XII.—General Principles of Hospital Construction, by F. H. Brown, in Buck's Hygiene and Public Health, vol. i.]

CHAPTER VIII.

Schools.

The hygiene of schools comprises the consideration of the sanitary principles underlying the construction of school-houses and school-furniture; the proper amount of time to be devoted to study at different ages; the special diseases of school-children, their causes, and means for their prevention.

CONSTRUCTION OF SCHOOL-HOUSES.

In the construction of school-houses the same hygienic principles are applicable as in dwelling-house construction. The selection of a site for the school-building should command the same careful consideration that is necessary in determining upon a site for a dwelling. Proximity to marshes and other unsanitary surroundings should be avoided. If the soil is damp it should be properly drained, and all sources of insalubrity in the neighborhood avoided or, if possible, removed.

School-houses should not be over three stories high; corridors and stairways should be wide, straight, and well lighted. All stairs should be securely built, and be guarded with ample, strong railing. All doors should open outward to permit ready egress and reduce the danger of accident in panics from any cause.

In addition to the study- or recitation- rooms, provision should be made for play and calisthenic-exercise rooms. Well-lighted and ventilated side-rooms should be provided for the reception of outside clothing, umbrellas, overshoes, etc. These articles should not be kept in the recitation- or study- rooms.

Floors should be made of accurately-joined flooring, and rendered impervious by oil or paraffine coating.

Appropriate measures must be employed to prevent the permeation of the building by ground-air.

The inside walls of school-rooms may be tinted a neutral gray, or light blue or green. Ceilings should be white. Walls and ceilings should not be painted, but lime-coated to permit free transpiration of air.

Schools should be so constructed as to permit of ready heating and ventilation, cleaning, and keeping clean. In large schools the method of heating will usually be by furnace-heated air, although a better method would probably be by steam- or hot-water pipes.

The ventilation of school-rooms must be carried out on the principles indicated in Chapter I. With careful and intelligent teachers, natural ventilation will give better satisfaction than a complicated artificial system. Where windows and doors must be largely depended upon for ventilation, the Bury window ventilator, illustrated on a previous page, will give satisfactory results unless the school-room is overcrowded. Opening the doors and windows when the pupils are out of doors—flushing the rooms with fresh air—is an excellent aid, and is even useful in cases where the most elaborate artificial system of ventilation is in use.

A model study-room, according to modern views, should be about 9 to 10 metres long, not over 7 metres wide, and 4 to $4\frac{1}{2}$ metres high. Such a room could be easily lighted by windows on one side only, and readily heated and ventilated. It would also enable the teacher to exercise a close supervision over his pupils. In a room of this size forty pupils would be a proper number, although fifty could be accommodated. The initial air-space for each pupil would be 5.60 cubic metres if there were fifty pupils in the room, and 7 cubic metres if there were only forty. This would be slightly reduced by the allowance for the teacher.

It is believed that study-rooms should face toward the north. The light entering from the north side of a building would be equable during a whole day. While a larger window

surface would be necessary than with an easterly or southerly exposure, it is held that the light, being devoid of all glare, would be more effective. Where the light is admitted on the east, south, or west sides of the building, the direct entrance of the sun's rays must be prevented by curtains, by means of which the amount and proper distribution of the light is regulated with difficulty.

The windows of the school-room should reach from about the height of the pupil's shoulder (when seated) to nearly or quite to the ceiling. Arches or overhanging cornices over the windows should be avoided, as they cut off much light. For the same reason the near proximity of other high buildings and of trees should be avoided in selecting a site for a school-house. The window area should be not less than one-fifth of the floor area, otherwise the light will be deficient.

The light should be admitted only from the left side of the pupil. When admitted from the right side the shadow cast by the pen in writing interferes with good vision; if admitted directly in front of the pupil, the glare of the light will injuriously affect the eyes; while, if it enter from behind, the book or paper of the pupil will be so much in shadow as to compel him to lean so far to the front in bringing his eyes nearer to book or paper that nearsightedness is very likely to be developed. Furthermore, if the light is admitted into the room at the backs of the pupils, the eyes of the teacher are liable to suffer from the constant glare.

In a school-room of the dimensions above stated, a row of windows on one side, forming an area of glass one-fifth of the floor-space, will thoroughly and satisfactorily illuminate the room, with the least unfavorable influence upon the organs of vision. It is advisable, therefore, to always insist on this arrangement of lighting of school-rooms. Where artificial light is used in a school-room, it should be in the proportion of one burner to every four pupils. All burners should be provided with chimneys and vertical reflectors.

Water-closets and privies should not be placed in cellars or basements. This would seem to be self-evident, and yet in many city school-houses these places of retirement are in this unsuitable location. When it is considered that large schools are frequently warmed by hot air taken from the cellar, it furnishes an additional reason to avoid this location for water-closets. On the contrary, the custom, in some country schools, of placing the privy at a considerable distance from the school-room and in an exposed situation, is almost equally reprehensible, as the pupils, especially girls, are prone to neglect obeying the calls of nature, from which neglect many disorders arise.

In a recently-introduced system of ventilation and excrement removal for schools, the closets are in the basement, and the excrement, as voided, is rapidly dried by a current of air, and the odor in this way quickly destroyed. Unfortunately, in thus drying the excrementitious matter, micro-organisms may be taken up in the air-currents and carried into the school-rooms.

SCHOOL FURNITURE.

Desks should be slightly sloping, the edge nearest the pupil being about 1 inch (2.5 centimetres) higher than his elbows. The front edge of the seat should project a little beyond the near edge of the desk, so that a plumb-line dropped from the latter should strike the seat near its front edge. If the seat is not thus brought slightly under the desk, the pupil is compelled to lean forward in writing, which position prevents proper expansion of the chest and increases the blood-pressure in the eyes,—a condition promotive of near-sightedness.

Seats should be only high enough so that the feet rest flat upon the floor. If they are higher, a foot-board must be provided. Children should not be condemned to the cruelty of having their feet dangling "between heaven and earth" while they keep their seats. Seats and desks should be graded according to the sizes of the pupils—not their ages or standing in the class.

An ideal seat and desk would be one made to measure for each pupil, but this is manifestly impracticable, inasmuch as with the constant growth of the child the seats would be rapidly outgrown.

The desk shown in Fig. 19[1] is adjustable to children of different sizes, and seems to solve the problem which has so long puzzled the school sanitarian. The desks are made for a single pupil and the seat and desk are independently adjustable.

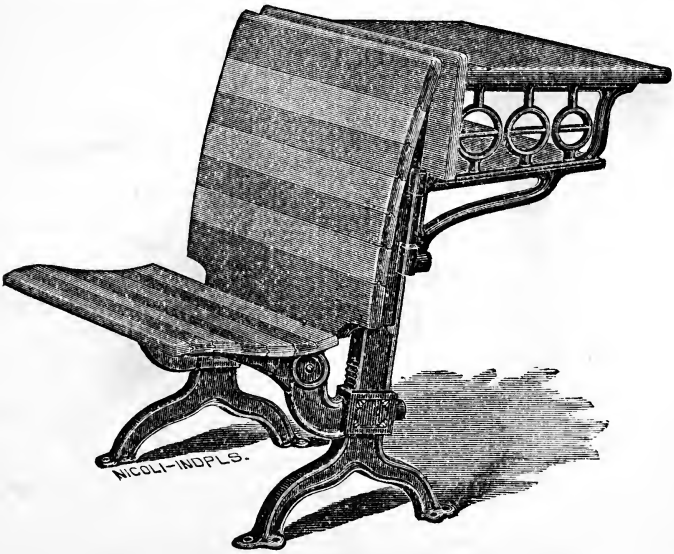

FIG. 19.—ADJUSTABLE SCHOOL-DESK. (Front View.)

The frame is of iron and the seat, back, and desk of hard-wood lumber.

Blackboards should not be placed at a greater distance than 10 metres from the farthest pupil. The ground of the board should be a dead black, without lustre. In writing exercises upon the board, care should be taken that the letters and figures are made sufficiently large, and with rather heavy strokes of the crayon, in order that they may be easily seen from the most distant part of the room. It has recently been demonstrated that a black letter on a white ground can be seen at a greater distance than

[1] Made by the Rushville School Furniture Company, Rushville, Ind., U. S. A.

a white letter on a black ground. Hence, it might prove advantageous to the eye-sight of school-children to substitute for the present blackboard and chalk, a white board and black crayon. In some European lecture-rooms this plan has been adopted with satisfaction.

AMOUNT OF TIME TO BE DEVOTED TO STUDY.

Young children should not be kept at the same study or in the same position for long at a time. The exercises should be frequently varied. It is especially with children in the primary grades that care should be taken not to overburden their minds with too many hours of study, or too long continuance at the same exercise.

Children should not be placed in school much, if at all, before the completion of their 7th year. From 7 to 9 years they should be kept at their studies not longer than three hours daily; from 9 to 12 years four hours may be allotted them; and from 12 to 16 years they may be kept at mental work five to six hours daily. This does not mean that pupils are to be kept continuously at their studies during these hours, but that they should be neither compelled nor permitted to study longer than these periods each day. It is believed that these figures represent the capacity for endurance in the majority of children, and they should be adopted in all schools where the largest return in mental acquirements is desired at the least expenditure of health. Excess of time expended in study is almost certainly followed by physical deterioration. "A little less brain: a little more muscle," for our children, is a legitimate demand that we may make of legislators and school-boards.

Gymnastic exercises should form part of the daily routine in all schools. These exercises should take place, when practicable, in the open air. Playing, romping, laughing, and singing should be encouraged, rather than the natural tendency to boisterous play restrained. It is especially desirable that female children should be encouraged to take part in these

diversions. The desire, on the part of many parents, to see little girls deport themselves as young ladies, before the time even when they write their age in two figures, is very reprehensible, and deserves the most unqualified condemnation. Molière's satirical remark, "Il n'ya plus d'enfants," seems to be literally true at the present day.

DISEASES OF SCHOOL-CHILDREN.

The principal diseases incident to school-life are myopia, spinal deformities, nervous and digestive disorders, pulmonary phthisis, and contagious diseases. It is believed that by judicious sanitary measures these can all be very much diminished and some entirely prevented.

It has been shown by the examination of the eyes of school-children that near-sightedness increases progressively from the lowest to the highest classes. Children who enter school with an hereditary tendency to myopia, or who are, perhaps, already near-sighted to a slight degree, soon become more intensely myopic; while others, who may be even hypermetropic on entering school, will be found to have become near-sighted during school-life. In examinations of over 30,000 pupils of grammar and high schools in Germany, Austria, Russia, and Switzerland, it has been found that the average proportion of near-sightedness is a fraction over 40 per cent., varying, in the different classes, from 22 per cent. for the lowest to 58 per cent. for the highest classes. These figures represent the averages of all the examinations made. In some particular schools, for example in the gymnasium (high school) of Erlangen, the percentage in the higher classes was 88 per cent., in the gymnasium of Coburg 86 per cent., and in the gymnasium of Heidelberg the proportion of myopic students in the highest class is said to have reached 100 per cent. in 1877. In the primary schools the percentage was found to be much lower. Recent investigations in the schools of Stockholm, by Widmark, show that among school-children examined under 7 years of age there was no

myopia. In the higher classes the myopia increases not only in degree, but in frequency. The diagrams, Figs. 20 and 21, show graphically the increase in degree and frequency of myopia in the several school-classes. These observations show that the number of myopic individuals bears a constant relation to the intensity of use of the visual organs. The results of the observation of different observers in different countries also

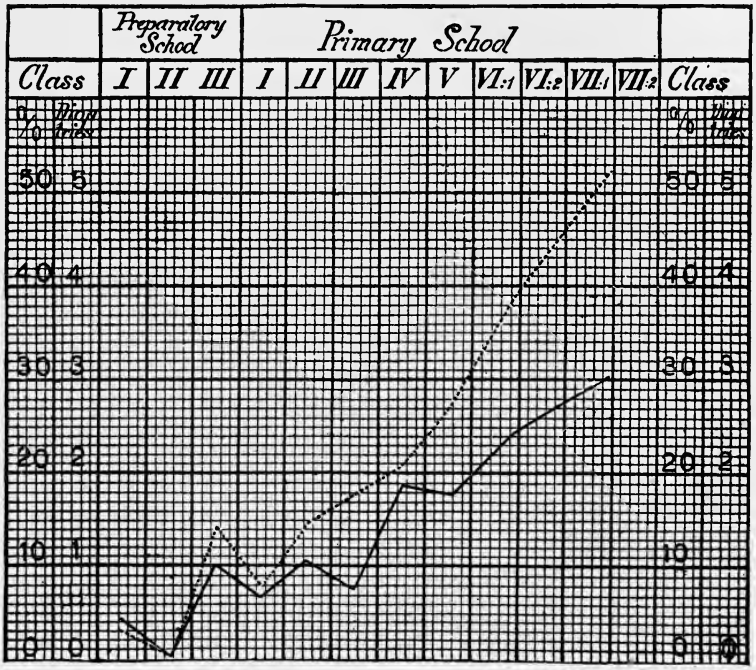

FIG. 20.—MYOPIA ACCORDING TO SCHOOL-CLASSES—BOYS.

uniformly point to the conclusion that not only does the number of near-sighted pupils increase as the higher classes are reached, but the degree of myopia increases likewise. Thus, a pupil who may have only a moderate degree of myopia on entering the school will have myopia in a higher degree as he advances in his classes. Erismann found, on re-examining the same pupils annually, that in six years 13.14 per cent. of those examined had developed myopia from emmetropia, while in 24.57

per cent. of near-sighted pupils the degree of myopia had increased.[1]

The principal causes of the prevalence of near-sightedness in schools are badly-arranged or insufficient light, bad air, overheating of the school-rooms, improper construction of desks compelling children to lean forward while reading or writing, and badly-printed text-books. The use of small type, poor paper, and bad press-work in text-books is very reprehensible. The type technically known as *Long Primer* is the smallest that

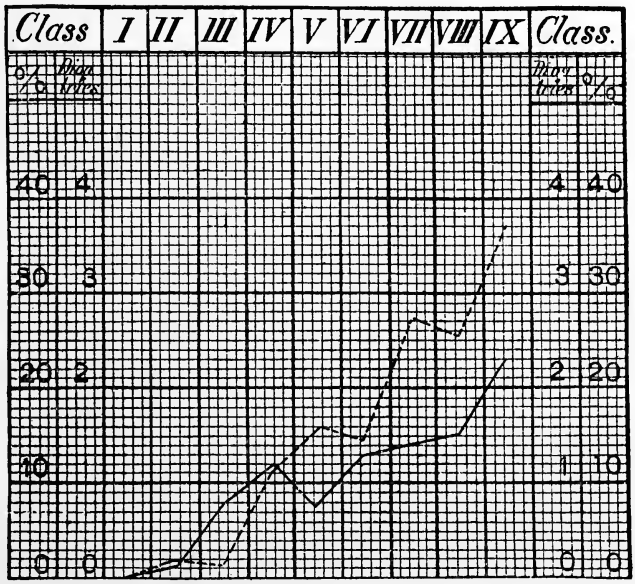

FIG. 21.—MYOPIA ACCORDING TO SCHOOL-CLASSES—GIRLS.

should be used in text-books. That badly-arranged light and improper seats are causes of myopia has been shown by Florschutz in his examinations of the pupils in the public schools of Coburg. He found that in the newer schools, in which the light and seats are better arranged, the percentage of near-sight decreased. The average percentage of those examined in 1874 was 21, while in 1877 it had been reduced to 15,[2] showing

[1] Erismann, Die Hygiene der Schule, in von Pettenkoffer und Ziemssen's Handbuch der Hygiene, II Th., 2 Abth., p. 30.

[2] Quoted by Cohn in Realencyclopædie d. ges. Heilk., Bd. XII, p. 263.

the great improvement due to the application of correct sanitary principles in the construction of school-houses.

Defective hearing has recently been shown to be especially frequent among school-children. A Berlin aurist found 1392 children out of 5902 (23.6 per cent.) suffering from ear disease of some kind. Dr. Samuel Sexton, of New York, and the late Dr. Chas. F. Percivall, director of music in the public schools of Baltimore, have arrived at similar results after examination of a large number of school-children.

Spinal curvature is present in a large proportion of the children attending schools. Statistics are not very full upon this subject, but one author, Guillaume, states that he found lateral curvature of the spine in 218 out of 731 school-children, —a proportion of 29.5 per cent. This, of course, includes the slighter degrees of curvature, which cannot properly be termed a disease. Among 30,000 Danish school-children 13 per cent. had some variety or degree of spinal deformity. M. Eulenburg[1] found that among 1000 persons with lateral curvature of the spine, the disease began in 887 between the ages of 6 and 14; that is to say, during the years of school-life. Girls are affected more than ten times as often as boys, the proportion being 93.43 per cent. in the former and only 6.57 per cent. in the latter.

The especial causes of spinal curvature occurring during school-life are improperly-constructed seats and desks and an improper position of the body. Many pupils habitually assume a "twisted" position, which is very liable to produce spinal distortion in children of weak muscular development. The manner in which a desk that is too high for the pupil may produce spinal distortion is very well shown in Fig. 22. An improper position is more likely to be unconsciously assumed by girls than by boys. The clothing is responsible for this, for when the girl files into her place behind the desk, her clothing, hanging loosely about her, is swept back and forms a pad, upon which

[1] Realencyclopædie d. ges. Heilk., Bd. XI, p. 564.

she sits with one buttock. The greater elevation of her seat on that side throws the spinal column out of the vertical line, which is compensated by a partial twisting of the trunk. The attention of teachers should be directed to this faulty habit, which can be easily corrected, and its consequences averted by timely interference.

Nervous disorders are comparatively frequent among school-children. Headaches are often due to insufficient ventilation, improper food, bad digestion, and excessive mental strain. Defective light may also be the cause of headaches by causing

FIG. 22.—SHOWING INFLUENCE OF A HIGH DESK IN CAUSING SPINAL CURVATURE.

ocular fatigue. Hysterical and imitative affections are not infrequent, and sometimes pass through entire schools, including even the teachers. Girls are, of course, more subject to this class of disorders than boys, but the latter are not entirely exempt.

Derangements of the digestive organs are exceedingly frequent among school-children. They can generally be traced to the use of improper food. The eating of cold lunches should be discouraged as much as possible.

Nuts, candies, pies, fruit-cakes, and, above all, pickles are

most fruitful sources of digestive derangements of children. The absence of proper accommodations to enable children—especially girls—to answer the demands of nature are frequent sources of digestive and nervous disorders.

The seeds of pulmonary consumption are frequently implanted during school-life. A neglected cough; bad ventilation, under which term may be comprised overheating and cold draughts, as well as polluted air; improper position of the body, excessive mental work, or underfeeding, may, any of them, be the starting-point of this fatal disease.

Especial care should be taken to prevent the introduction or dissemination of contagious diseases through schools. The importance of this duty should be at all times impressed upon school-boards and teachers. In the first place, no child should be admitted within the door of the school-room unless it first presents undoubted evidence of protection against small-pox, either by having passed through a previous attack or by a proper vaccination. In case of an actual or threatened epidemic of small-pox the entire school, including teachers, should be vaccinated.

Diphtheria has been shown to be frequently spread through the agency of schools.[1] This fatal disease demands especial precautions on the part of teachers and others involved in the management of schools, to prevent its introduction to these institutions.

Children should not be admitted to school coming from a house where there is at the time, or has recently been, a case of contagious disease, such as small-pox, diphtheria, scarlet fever, or measles. At least four weeks should be allowed to elapse after the termination of such disease before a child from the infected house is re-admitted to the school. It goes without saying that no child having itself been sick with a contagious disease should be admitted to school until entirely restored to

[1] The Relations of Schools to Diphtheria and to Similar Diseases, H. B. Baker, Public Health, vol. vi, p. 107.

health. The aforesaid limit of four weeks is the briefest period allowable before the quarantine of the infected house (so far as the schools are concerned) can be relaxed.

When a case of contagious disease has accidentally obtained entrance to the school, the pupils should be dismissed for the day, and the room thoroughly disinfected by means of sulphur, chlorine, or, what is better, scrubbing and spraying with solution of mercuric chloride.

Teachers are not infrequently guilty of the grave imprudence of sending pupils from the school to the house of an absent child to inquire the reason of the latter's non-appearance at school. It frequently happens that the absent child is sick, and the messenger is invited to the sick-room to see his or her classmate. There can be no room for doubt that scarlet fever, diphtheria, and measles have often been introduced into schools in consequence of such thoughtlessness on the part of teachers.

In order to promote the proper hygienic management of schools, all teachers should be required to submit to an examination in the principles and practice of hygiene, at least so far as school hygiene especially is concerned. This is a demand that school-boards could reasonably insist upon, and there can be no question that the improvement in the health of the pupils would amply justify the innovation.

[Students may consult with advantage the following special articles:—

D. F. Lincoln, School Hygiene, in Buck's Hygiene and Public Health, vol. ii, and Lomb Prize Essay on School Hygiene, Concord, N. H., 1887.—F. Erismann, Die Hygiene der Schule, in Von Pettenkofer und Ziemssen's Handb. d. Hygiene, II, Th. 2 Abth.—Reuss, Schulbankfrage, in Realencyclopædie d. ges. Heilk., Bd. XII.—H. Cohn, Schulkinderaugen, *ibid.*—C. J. Lundy, School Hygiene, Public Health, vol. ix.—Rohé, The Necessity of the Sanitary Supervision of Schools, Journ. Am. Med. Ass'n, Dec. 28, 1889.]

CHAPTER IX.

Industrial Hygiene.

One of the most interesting chapters in the study of hygiene is that which treats of the relations of occupations to health and life. While it is unquestionable that certain occupations are intrinsically dangerous to health, there can be no doubt that in many instances incidental conditions not necessarily connected with the occupation are factors in the production of disease. Such factors are bad ventilation and other insanitary surroundings, as well as in many cases want of sufficient or proper food.

Occupations induce disease by compelling the workmen to inhale irritating, poisonous, or offensive gases, vapors, or dust; or by causing the absorption through the skin or mucous membranes of irritating or poisonous substances. Changes of temperature, as exposure to great heat or cold, produce diseases which are, in some instances, characteristic. In another class of cases the excessive use of certain organs, as the nervous system, the eyes, the vocal organs, or various groups of muscles, produce characteristic morbid effects. Again, a constrained attitude while at work, a sedentary life, or occupations involving exposure to mechanical violence are recognized sources of disease and death.

The following table gives the mortality and average age at death of all decedents over 20 years of age whose occupation was specified, in the State of Massachusetts, for thirty-one years and eight months. The total number of decedents was 144,954; the average age at death, 50.90 years. Subdivided into classes and individual occupations, the results are as follow:—

Table XX.

Occupations of Persons whose Occupations were specified, and whose Deaths were registered in Massachusetts during a period of thirty-one years and eight months, ending with December 31, 1874.[1]

Occupations.	Number of Persons.	Average Age at Death.	Occupations.	Number of Persons.	Average Age at Death.
Class I. *Cultivators of the Earth:* Farmers, Gardeners, etc.	31,832	65.29	Nail-makers	174	41.49
			Pail- and Tub-makers	5	36.60
			Painters	1,850	45.07
			Paper-makers	288	48.29
Class II. *Active Mechanics Abroad*	10,893	56 19	Piano-forte-makers	111	43.33
Brick-makers	106	46.85	Plumbers	131	35.53
Carpenters and Joiners	6,150	53 33	Potters	40	56.67
Caulkers and Gravers	180	58.59	Pump- and Block-makers	89	54.79
Masons	1,662	50.33	Reed-makers	9	42.78
Millwrights	118	59.14	Rope-makers	248	58.05
Riggers	161	52.25	Tallow-chandlers	67	54.93
Ship-carpenters	873	58 53	Tinsmiths	375	41.05
Slaters	81	40.99	Trunk-makers	48	39.60
Stone-cutters	1,025	40.90	Upholsterers	124	38.82
Tanners	537	50.36	Weavers	480	44.95
			Wheelwrights	507	56.98
			Wood-turners	76	52.07
Class III. *Active Mechanics in Shops*	16,576	47.57	Mechanics (not specified)	2,015	44.84
Bakers	471	47.04			
Blacksmiths	2,402	53.26			
Brewers	28	47.11	Class IV. *Inactive Mechanics in Shops*	17,233	43.87
Cabinet-makers	781	48.84	Barbers	403	39.81
Calico-printers	9	52.11	Basket-makers	70	61.63
Card-makers	39	48.23	Book-binders	150	40.12
Carriage-makers and Trimmers	276	48.21	Brush-makers	53	43.11
Chair-makers	138	41.77	Carvers	90	34.00
Clothiers	84	56.50	Cigar-makers	154	38.36
Confectioners	85	44.11	Clock- and watch-makers	100	52.86
Cooks	112	40.82	Comb-makers	134	51.38
Coopers	927	59.22	Engravers	124	40.88
Coppersmiths	101	45.89	Glass-cutters	76	43.16
Curriers	366	41.50	Harness-makers	423	48.74
Cutlers	131	39.21	Jewelers	468	40.34
Distillers	27	56.85	Operatives	2,138	39.16
Dyers	143	45.17	Printers	717	38.62
Founders	361	42.51	Sail-makers	217	53.21
Furnace-men	133	43.42	Shoe-cutters	362	42.94
Glass-blowers	132	37.88	Shoe-makers	9,772	44.61
Gunsmiths	250	48.86	Silver or Gold smiths	92	46.13
Hatters	356	54.67	Tailors	1,393	47.34
Leather-dressers	179	47.23	Tobacconists	43	50.35
Machinists	2,097	41.67	Whip-makers	99	42.63
Millers	278	57.14	Wool-sorters	155	48.09
Musical-Inst. mkrs.	33	46.73			

[1] Thirty-third Registration Report of Massachusetts, p. cvi *et seq.*

TABLE XX (*continued*).

OCCUPATIONS.	Number of Persons.	Average Age at Death.	OCCUPATIONS.	Number of Persons.	Average Age at Death.
CLASS V. *Laborers* (no special trades)	28,058	47.41	Gentlemen	1,512	68 42
Laborers	27,382	47.49	Grocers	517	47.59
Servants	389	40.10	Innkeepers	467	50.04
Stevedores	76	52.09	Manufacturers	1,375	51.23
Watchmen	193	50 06	Merchants	3,927	54.17
Workmen in Powder-mills	18	39.67	News-dlrs. and Car'rs	27	41.22
CLASS VI. *Factors Laboring Abroad, etc.*	7,035	36.29	R. R. Agents or Conductors	318	39.85
Baggage-masters	37	34.08	Saloon- and Restaurant- keepers	299	40.90
Brakemen	246	26.44	Stove-dealers	12	45.25
Butchers	537	50.19	Telegraphers	5	28.80
Chimney-sweeps	4	34.50	Traders	2,908	48.08
Drivers	327	38 88	CLASS IX. *Professional Men*	5,175	50.81
Drovers	17	49.29	Architects	29	47.07
Engin'rs and Firemen	567	38.77	Artists	186	44.18
Expressmen	216	41.30	Civil Engineers	117	42.32
Ferrymen	9	53.78	Clergymen	965	58 57
Lighthouse-keepers	10	60.40	Comedians	32	37 31
Peddlers	417	45.18	Dentists	114	41.61
Sextons	81	59 94	Editors and Reprtrs.	87	46.68
Soldiers	2,885	28 37	Judges and Justices	18	64.11
Stablers	354	42.54	Lawyers	676	56.45
Teamsters	1,282	40.35	Musicians	266	41.59
Weighers and Gaugers	24	60.67	Photographers	10	36.80
Wharfingers	22	50.00	Physicians	1,166	54.99
CLASS VII. *Employed on the Ocean*	8,844	46.44	Professors	45	55.93
Fishermen	433	42.82	Public Officers	437	55.37
Marines	4	41.25	Sheriffs, Constables, and Policemen	158	53.76
Naval Officers	58	50.00	Students	288	23.23
Pilots	82	60.38	Surveyors	86	51.44
Seamen	8,267	46.45	Teachers	495	41.79
CLASS VIII. *Merch'ts, Financ'rs, Ag'ts, etc.*	15,977	48.95	CLASS X. *Females*	3,343	39.13
Agents	376	46.76	Domestics	1,037	46 64
Bankers	49	57.61	Dress-makers	259	43.36
Bank Officers	151	55.14	Milliners	136	39.42
Boarding-House kprs.	75	47.96	Nurses	116	61.06
Book-sellers	73	53 05	Operatives	703	27.82
Brokers	198	49.58	Seamstresses	289	46.50
Clerks and Book-kprs.	3,435	35.93	Shoe-binders	48	43.12
Druggists and Apothecaries	255	42.37	Straw-workers	73	34 83
			Tailoresses	233	47.49
			Teachers	442	31.27
			Telegraphers	7	24.43

The above table cannot be absolutely relied upon for several reasons, the principal of which is that the table is incomplete. Many of the occupations are merely temporary, and persons are

constantly shifting from the pursuit of one calling to another. Judges and lawyers, for example, should be included under one heading, while the class "students" should be excluded altogether. The table shows, however, very clearly, the relations of certain occupations to longevity. It is seen, for example, that agriculturists have the greatest expectation of life. Next to these come mechanics engaged out-of-doors. Professional men come next, and of these clergymen and members of the bar have the first and second places, respectively. The expectation of life of physicians is above the average, being nearly 55 years. Mechanics engaged in active work in-doors may expect to live 3.70 years longer than those whose occupation requires them to retain a more or less constant position.

Occupations which are accompanied by the formation of much dust, either inorganic or organic, are especially unfavorable. They usually produce diseases of the respiratory organs, which may eventuate in phthisis. In the table it is seen that the average age at death of stone-cutters was 40.90; of cotton-factory operatives—male 39.16, female 27.82;[1] of cigar-makers, 38.36; and of cutlers, 39.21 years. The figures more or less closely approximate the conditions which have been shown to exist in England and on the Continent of Europe. In Sheffield, the workmen who grind and polish the cutlery, called "dry grinders," are said to suffer from a characteristic pulmonary affection termed "grinders' asthma" (emphysema) in the proportion of 69 per cent. of the whole number employed. The average duration of life of the needle-grinders of Derbyshire is 30.66 years. Among the cutlery-grinders of Solingen, in Rhenish Prussia, Oldendorff found 29 per cent. suffering from pulmonary affections, while the average age at death of the "dry grinders" was 40.7 years.

[1] These figures must be accepted with much reserve. While it is probable that the average age at death among women engaged in different occupations is less than that of men engaged in the same occupations, the figures in Table XX, Class X, cannot be used as a basis of comparison. So many women are annually withdrawn from the various occupations by marriage, which places them under different conditions, that the statistics of the occupations of women in the table are untrustworthy.

OCCUPATIONS PREJUDICIAL TO HEALTH.

The diseases of occupations may conveniently be divided into the following classes:—

1. Diseases due to the inhalation of irritating or poisonous gases and vapors.
2. Diseases due to the inhalation of irritating or poisonous dust.
3. Diseases due to the absorption or local action of irritating or poisonous substances.
4. Diseases due to exposure to elevated or variable temperature or atmospheric pressure.
5. Diseases due to excessive use of certain organs.
6. Diseases due to a constrained attitude and sedentary life.
7. Diseases from exposure to mechanical violence.

I.—DISEASES DUE TO THE INHALATION OF IRRITATING OR POISONOUS GASES OR VAPORS.

Sulphurous-acid gas is used in various trades as a bleaching agent. In the manufacture of straw hats and in the drying or "processing" of hops this agent is extensively employed, and the people engaged in these industries frequently suffer from respiratory and digestive disorders. These are, however, rarely serious. If free access of air is allowed, the dangers to health in the above employments are very slight.

Nitric-acid fumes may be dangerous to health when inhaled in a concentrated form, but very few cases are on record where any positively deleterious influence can be traced to this agent.

Hydrochloric-acid fumes may prove deleterious to the workmen in soda manufactories, where the fumes are disengaged during the so-called "sulphate process." But the danger is probably slight. On the other hand, attention has recently been called to a peculiar effect of hydrochloric-acid fumes upon the workmen in fruit-canning establishments. The men who seal or "cap" the cans after being filled are the ones affected. The

lesion has been described by Dr. W. Stump Forwood, who says concerning it: "The constant inhalation of the fumes of muriatic acid, associated as they are with the lead solder, which the busy "capper" neglects to protect himself against, soon produces inflammation of the mucous membrane of the nose, which finally results in ulceration. With some patients, after the removal of the cause and the application of proper treatment, recovery takes place after two or three months; but with those who have a scrofulous taint in their constitutions this ulceration is exceedingly intractable, and, in spite of all treatment, proceeds for months and even years, until the septum is finally perforated. And, strange to say, it is the common experience of those who have suffered that, as soon as perforation takes place, all the soreness and consequent annoyance disappears and the patient recovers, with, of course, a permanent opening in the nasal septum."[1] Dr. Forwood adds that anointing the nose, both within and without, several times a day, and avoidance of the acid fumes as much as possible, will prevent the peculiar affection.

Ammonia rarely causes disturbances of health in workmen brought into contact with it. When present in the air in large proportion it may give rise to serious symptoms. As it is often used to prevent the poisonous effects of mercury (*q. v.*), care should be taken that the proportion of the vapor in the air of the work-room should not exceed 5 per cent.

Chlorine gas is very deleterious in its effects upon the workmen brought in contact with it in the various industries in which it is employed. Nearly one-half of the workmen engaged in the manufacture of chlorinated lime and in bleaching become affected.

The respiratory organs are principally attacked. Pneumonia is exceptionally frequent. If an affected individual is predisposed to consumption the latter disease is soon lighted up, and quickly proves fatal. The effect of the inhalation of concentrated chlorine is thus graphically described by Hirt[2]: "The

[1] Phila. Med. and Surgical Reporter, June 30, 1883.
[2] Von Pettenkofer und Ziemssen's Handbuch der Hygiene, etc., II Th., 4 Abth., p. 30.

workman suffers from violent cough and extreme dyspnœa. In spite of the aid of the auxiliary respiratory muscles, the entrance of air to the lungs is insufficient, and the widely-opened eyes, the pale-bluish color, and the cold perspiration plainly show the mortal agony of the patient. With this the pulse is small, the temperature decreased. Soon after removal from the impregnated atmosphere these phenomena disappear, and a few hours later the workman is found enveloped in chlorine and hydrochloric-acid vapors in his accustomed place in the factory. The attacks seem to be but rarely fatal."

The constant inhalation of an atmosphere strongly impregnated with chlorine produces a cachectic appearance, bronchial catarrh, loss of the sense of smell, and a prematurely aged appearance. When this stage of chronic chlorine poisoning has been reached complete health can rarely be re-established, even if the patients be entirely removed from the irritating atmosphere.

Carbon monoxide is often present in the air of gas-works, iron smelting-works, and coke or charcoal furnaces. The workmen engaged in these industries often suffer with diseases of the respiratory organs, digestive disturbances, and general debility. Acute poisoning from carbon monoxide is relatively frequent, as already pointed out.[1] The prominent symptoms are at first violent headache, dizziness, and roaring in the ears. These symptoms are followed by great depression of muscular power, nausea, and vomiting. The vomited matters sometimes gain entrance into the trachea, and may thus produce strangulation. Unconsciousness, convulsions, and asphyxia rapidly succeed. Paralyses of the sphincters and of groups of other muscles are often present. The pulse is at first somewhat increased, but soon becomes slower. The respiration is slow and stertorous, and the temperature falls from 2.5° to 3° C. (3° to 4° F.). Glycosuria often occurs. If death does not occur in the attack, the patient frequently suffers from great depression, both physical and mental; loss of appetite, constipation, and various paretic conditions.

[1] See Chapter I, p. 29.

The slow or chronic form of poisoning by carbon monoxide is characterized by headache, dizziness, slow pulse and respiration, nausea, and sometimes vomiting and purging. Loss of memory and diminution of mental activity are also said to be effects of the continued inhalation of air charged with carbon monoxide.

Carbon dioxide is found as one of the constituents of the "choke-damp" in mines. There is reason to believe that this is often the source of ill health and death in miners, even where the symptoms of acute carbon-dioxide poisoning are not present. Hon. Andrew Roy[1] says that "it is more insidious than direct in its operations, gradually undermining the constitution and killing the men by inches." Difficulty of respiration and weakness are the only symptoms calling attention to the pernicious effects of the gas. Where, however, the proportion of carbon dioxide is large, acute poisoning occurs. This is manifested by the following symptoms: Loss of consciousness and of the power of voluntary motion. In some cases there are convulsions; in others the above symptoms are preceded by difficult respiration, headache, depression, drowsiness, or psychical excitement. Recovery usually soon follows after removing the patient into a purer atmosphere.

Vintners, distillers, brewers, and yeast-makers are said to suffer from the effects of carbon dioxide occasionally, but serious results from this cause are probably very infrequent.

It may not be amiss to call attention here to another dangerous mixture of gases sometimes found in mines, and which is occasionally the source of appalling accidents. This is the so-called "fire-damp" or light carburetted hydrogen (CH_4). When this gas is mixed with atmospheric air in the proportion of 6 to 10 volumes per cent., the mixture becomes violently explosive if ignited. The danger does not cease with the explosion, however, for in this act the free oxygen present is consumed

[1] Third Annual Report State Mine Inspector of Ohio. Quoted in Buck's Hygiene and Public Health, vol. ii, p. 243.

in the formation of carbon dioxide, and the workmen then die asphyxiated, or from the effects of "choke-damp." The dangers from "fire-damp" can be largely averted by thorough ventilation and by the use of the safety-lamp of Sir Humphry Davy, which gives warning of the presence of the gas and permits the workmen to escape before the explosion takes place.

Sulphuretted hydrogen, when present in the air in large proportion,—as, for example, in privy-vaults, cess-pools, and sewers,—may produce serious or fatal poisoning. Formerly, when vaults were cleaned in the primitive way, these accidents were frequent; but at the present day, owing to improved methods of removing excreta, they are comparatively rare. The precautions advised in a preceding chapter[1] should be borne in mind when it is necessary for workmen to enter such places.

The gases resulting from the *putrid decomposition of organic substances*, such as are found in tanneries, glue- and soap- works, and similar industries, are popularly believed to give rise to various diseases. There are no observations on record, however, to show that such is the case. As a matter of fact, the workmen engaged in the industries mentioned, seem to be exceptionally healthy, and to resist to a considerable degree the ravages of phthisis and epidemic diseases.

Bisulphide of carbon is used in the arts principally in the process of vulcanizing India rubber, and for extracting oils from seeds and fatty bodies. The constant inhalation of the vapor of bisulphide of carbon produces a train of symptoms to which attention was first attracted by Delpech in 1856. The symptoms have been observed frequently since that time. The following account is from Hirt[2]:—

"Some days, or even weeks or months, after beginning this occupation, the workmen complain of a dull headache, becoming more severe toward evening. This symptom is soon followed by joint-pains, formication, and itching on various parts of the body. A more or less troublesome cough is present, but is not accom-

[1] Chapter I, p. 37.

[2] *Op. cit.*, p. 66.

panied by any characteristic sputa. The respiration is regular, the pulse somewhat increased in frequency. During this time certain individuals exhibit a marked exaltation of their intellectual powers; they talk more than formerly, and show an interest in matters in which they at other times show no concern. There is, however, very rarely distinct mental disease. The sexual desires are increased in both sexes, menstruation becomes irregular, and the urine possesses a faint odor of bisulphide of carbon. In this manner several weeks or months pass away. Very gradually the psychical exaltation disappears, and a profound depression, melancholy, and discouragement succeeds, coupled with which is often loss of memory. Vision and hearing become less acute, and the sexual activity is completely destroyed. Anæsthetic spots appear on various parts of the body, and numbness of the fingers prevents the workman from performing any fine work."

The disease never proves fatal, but the normal condition of the individual is rarely re-established when the disorder has advanced to the extreme stages mentioned.

Iodine and bromine vapors, when inhaled by workmen engaged in their preparation, produce symptoms of poisoning which are sometimes very serious. Acute iodic intoxication consists in severe laryngeal irritation, headache, conjunctivitis, and nasal catarrh. Occasionally there is temporary loss of consciousness. Chronic iodic cachexia is often found among the workmen. In certain cases atrophy of the testicles and gradual disappearance of sexual power has been observed. In the manufacture of bromine, a form of bronchial asthma has been observed among those engaged in the establishment. No symptoms corresponding to those of chronic iodism have been observed among the workmen in bromine.

The inhalation of the vapors of *turpentine* produces, in a considerable number of those constantly exposed to them, diseases of the respiratory organs, beginning with cough and, at times, resulting in consumption. In other cases derangement

of the digestive organs, strangury, and, in a few cases, bloody urine have been observed. Nervous disturbances are rare after the inhalation of turpentine, and are limited to headache, roaring in the ears, or flashes of light before the eyes.

Petroleum vapor, when inhaled in a concentrated state, produces symptoms similar to those of anæsthetics. When exposed for a long time to diluted petroleum vapor, workmen sometimes suffer from chronic pulmonary catarrhs or from nervous derangements. Among the latter are disturbances of mental activity, loss of memory, giddiness, and headache. These symptoms are, however, rare. More frequent are pustular or furuncular affections of the skin, which are due probably to the direct irritant effect of the vapor.

Lead poisoning is one of the most characteristic diseases of artisans. It attacks workmen engaged in the roasting and smelting of lead ores; in the manufacture of white and red lead and of lead acetate and chromate; in type-making, in painting, and, in short, in all occupations in which the workman is compelled to inhale the vapor or dust of lead, or in which it is conveyed in some manner to the digestive organs. It is believed also that it can be absorbed by the skin and produce its poisonous effects upon the economy. The average duration of life in the roasting and smelting furnaces is 41 years; of painters, as shown by Table XX, 45.07 years. Of the latter 75 per cent. are attacked by one of the forms of lead poisoning, colic being most frequent. In the manufacture of white lead more than half of the workmen suffer from lead poisoning during the first year, lead colic being present in 60 per cent. of all the cases.

In most sugar-of-lead manufactories 60 per cent. of all the operatives constantly suffer from some form of lead poisoning.

Poisoning has also been observed in workmen engaged in the manufacture of various pigments of which the acetate of lead is the base (*e.g.*, lead chromates). Among type-founders the symptoms of lead poisoning are not very rare, and even

compositors sometimes suffer from lead poisoning. In the latter case the lead must be absorbed through the skin in order to produce its effects.

The various forms in which lead poisoning affects the individual are the lead cachexia, manifested by loss of weight, discoloration of the skin, the characteristic blue line along the gums, diminution of the salivary secretion, a sweetish taste, and offensive odor of the breath; then lead colic, the features of which are well known; lead paralysis, the characteristic "wrist-drop," which requires prompt and intelligent treatment, otherwise permanent atrophy of the affected muscles often takes place. Among other nervous manifestations of the poison is a painful affection of the lower extremities, attacking joints and flexor muscles, and remittent in character. At times anæsthesia of the skin of the head and neck is present. In rare cases serious mental derangement occurs. Other grave nervous lesions, such as the so-called saturnine hemiplegia and tabes, are happily extremely rare among the workmen in the metal at the present day.

Mercurial poisoning is frequent among the artisans who work in the metal. The smelters of the ore suffer severely and in a large proportion of the entire number employed. Their average age at death is 45 years. Mirror-makers suffer most severely of all the artisans who come in contact with the vapors of the metal. It is beyond question that the confinement in badly-ventilated work-rooms is largely responsible for the poisonous effects of the metal upon this class. The special forms in which the poisonous effects are manifested in mirror-makers are salivation, mercurial tremor, and nervous erethism, but, in addition, a very large proportion suffer from pulmonary consumption. It is stated that 71 per cent. of the total deaths among mirror-makers (those who coat the glass with the mercurial alloy) are from phthisis.

Among women the symptoms are aggravated, and abortion frequently occurs. Of the children of women suffering from

mercurial poisoning born living at term, 65 per cent. die within the first year.

In the Almaden quicksilver mines in Spain a considerable proportion of the workmen suffer from the milder symptoms of mercurial intoxication (gingivitis, salivation, or dryness of the mouth). The more severe manifestations (tremor, convulsions, contractures, violent muscular pains, paralysis, cachexia) are much less frequent, and latterly not so severe as they were formerly.

Fire-gilders, fulminate-makers, and physical instrument-makers not infrequently suffer from the deleterious effects of inhaling the vapor of mercury. Hatters are also liable, to a considerable extent, to the poisonous effects of the metal.[1]

It has been found that upon sprinkling the floor of the work-room of mirror-makers with aqua ammonia, so as to impregnate the atmosphere with ammonia, the bad effects of mercury on the system are markedly diminished. Care must be taken, however, not to use the ammonia to excess, otherwise the diseases caused by this agent may attack the workmen.

Zinc or copper vapors, or possibly a combination of the two, given off from the brass, which is an alloy of these metals, produces a peculiar train of symptoms known as "brass-founders' ague." The symptoms are described by Hirt, who has suffered from two attacks of the affection himself, as follows[2]: "A few hours after attending the process of brass-casting, one notices a peculiar, uncomfortable sensation over the whole body. More or less severe pains in the back and general lassitude cause a discontinuance of the ordinary occupation. While the pains appear now here, now there, and are extremely annoying, no changes in the pulse or respiration are noticeable. In a short time, however, usually after the patient has taken to the bed, chilliness comes on, which soon increases to a decided rigor, lasting fifteen minutes or longer. In the

[1] Hatting as Affecting the Health of Operatives, L. Dennis, Report New Jersey State Board of Health, 1879; Connecticut State Board of Health, 1883.

[2] *Op. cit.*, p. 122.

course of an hour or less the pulse now reaches a rapidity of 100 to 120 beats per minute. A tormenting cough, combined with a feeling of soreness in the chest, comes on. In consequence of the repeated acts of coughing, the increasing frontal headache produces exceeding discomfort. Soon, however, usually after a few hours, the height of the attack is reached; free perspiration indicates the stage of defervescence, and during the gradual diminution of the symptoms the patient falls into a deep sleep, lasting several hours. On awakening, a slight headache and lassitude only remain as reminders of the attack."

It is said that about 75 per cent. of the workmen in brass-foundries are attacked by this affection; the attack is liable to be repeated at every exposure.

A chronic form of poisoning is said to occur among zinc-smelters after following their occupation for ten to twelve years. It consists of hyperæsthesia, formication, and burning of the skin of the lower extremities, soon followed by alteration in the temperature and tactile sensation, and diminution of the muscular sense. Paresis of the lower extremities sometimes comes on. The disease has not yet been sufficiently investigated.

Aniline vapor is exceedingly poisonous when inhaled in a concentrated state. Hirt describes an acute form which usually results fatally: "The workman falls suddenly to the ground; the skin is cold, pale; the face is cyanotic, the breath has the odor of aniline, the respiration is slowed, and the pulse increased. The sensation, diminished from the beginning of the attack, gradually entirely disappears, and death follows in a state of deep coma."[1] There is a milder form which comes on after several days of exposure. It is characterized by laryngeal irritation, diminution of appetite, headache, giddiness, great weakness, and depression. The pulse is rapid, small, and irregular. Respiration is little altered. There is decrease of sensibility of the skin. Convulsions may occur, but are usually of short duration.

[1] *Op. cit.*, p. 127.

The chronic form of aniline poisoning is characterized by three sets of symptoms: those affecting the central nervous system, the digestive tract, and the skin. Among the first are lassitude, headache, roaring in the ears, and disturbances of sensation and motion of greater or less degree.

The digestive derangements consist in eructations, nausea, and vomiting.

The cutaneous lesions are eczematous or pustular eruptions, and sometimes round, sharply-circumscribed ulcers with callous borders.

There is no trustworthy evidence that in the manufacture of *aniline colors* poisonous symptoms are produced in the workmen.

II.—DISEASES DUE TO THE INHALATION OF IRRITATING OR POISONOUS DUST.

The inhalation of air containing particles of organic or inorganic matter has long been accepted as a cause of certain special diseases of artisans. The diseases so caused are usually limited to the pulmonary organs, and consist of acute and chronic catarrh, emphysema of the lungs, pneumonia, interstitial inflammation of the lungs,—the so-called fibroid phthisis or pulmonary cirrhosis.

Coal-dust is inhaled by coal-miners, charcoal-burners, coal-handlers, firemen, chimney-sweeps, foundry-men, lead-pencil makers, etc. Chronic bronchial catarrhs are most frequent, while phthisis and emphysema are almost absent from the list of diseases affecting these workmen. Dr. W. B. Canfield has reported an interesting case of pneumonoconiosis in which there was coincident bacillary phthisis.[1] The table on page 208 shows that the expectation of life of foundry-men, furnace-men, firemen, and chimney-sweeps is much below the average.

Metallic dust is inhaled by blacksmiths, nailers, cutlers, locksmiths, file-cutters, cutlery- and needle- polishers, etc. While

[1] Trans. Med. and Chir. Fac., Md., 1889.

in this class of workmen cases of bronchitis and pneumonia are relatively frequent, much the largest proportion suffer from phthisis. A table compiled by Hirt shows that out of the total number of sick in the different classes of workmen the cases of phthisis were:—

62.2 per cent. for file-cutters,
69.6 " " needle-polishers,
40.4 " " grinders,
12.2 " " nailers.

The Massachusetts table gives the average duration of life for blacksmiths at 53.26 years, of nail-makers at 41.49 years, and of cutlers at 39.21 years. The needle-polishers at Sheffield, as already stated (page 210), have only an average duration of life of 30.66 years. In this work and that of grinding knives, scissors, and similar articles, the metallic dust is mixed with mineral dust (particles of silica from the grindstone). This mixture seems to be much more deleterious than metallic dust alone, as shown by the shorter average duration of life and the enormous percentage of cases of consumption.

Mineral dust is inhaled by the workmen in a large number of different industries. The grinders in the ground-glass factories suffer most severely. Hirt found the average duration of life in grinders who began this occupation after their 25th year to be 42.50 years, while in those who began at the age of 15 the average duration was 30 years.

Millstone cutting is also a very dangerous occupation. Peacock[1] gives the average age of these workmen at 24.1 years. Stone-cutters generally suffer frequently from phthisis, probably largely in consequence of the constant inhalation of the mineral dust produced during their work. The Massachusetts table gives the average age at death of these workmen at 40.90 years, while Hirt's table gives a much lower age, namely 36.3 years. Potters and porcelain-makers are exposed to similar dangers from their occupation, but to a much less degree. The table on

[1] Quoted by Merkel, in von Pettenkofer und Ziemssen's Handbuch der Hygiene, II Th., 4 Abth., p. 197.

page 208 gives the average age at death at 56.67 years,—rather a high average.

Slaters and workmen in slate-quarries suffer in a large proportion of cases from chronic pneumonia, and die at a comparatively early age.

Masons and carpenters have an average duration of life of 50.33 and 53.33 years, respectively. One-third of all the diseases from which they suffer affect the respiratory organs.

Gussenbauer has reported a very interesting series of cases of a peculiar inflammatory affection of the diaphyses of the long bones in the artisans who are engaged in the manufacture of pearl buttons.

Gem-finishers are exposed not only to the inhalation of dust, but to poisonous gases (carbon monoxide) and vapors (lead). The proportion of sickness among them is very high.

Vegetable Dust.—The workmen compelled to inhale vegetable dust are those who work in tobacco, cotton-operatives, flax-dressers, paper-makers, weavers, wood-turners, millers, and laborers in grain-elevators.

Workmen in tobacco usually suffer, within a few weeks after beginning work, from a nasal, conjunctival, and bronchial catarrh, which soon passes off, as the mucous membranes seem to become accustomed to the irritation. Nausea is also frequent at first, due probably to the absorption of small quantities of nicotine. Females exposed to tobacco-dust usually suffer from digestive and nervous troubles. They are also said to abort frequently.

Dr. R. S. Tracy,[1] as a result of his observations among cigar-makers in New York, states that the fecundity of these people is much less than the average. Three hundred and twenty-five families visited had only 465 children, an average of 1.43 to each family. Dr. Tracy is inclined to attribute this to the frequent abortions that occur among the females exposed to the inhalation of tobacco-dust. According to the Massachusetts

[1] Buck's Hygiene and Public Health, vol. ii, p. 62.

table, cigar-making is an unfavorable occupation, the average age at death being 38.36 years.

Cotton-operatives, flax-dressers, weavers, and workmen in paper-mills are subject to various diseases of the respiratory organs. Coetsem, as long ago as 1836, described a peculiar pulmonary affection among cotton-operatives, which he termed *pneumonie cotonneuse.* The observation does not seem to have been verified by others; at all events, the author is unable to find any other record of a similar affection in the literature of the subject. Among weavers the mortality from phthisis is comparatively high. Among paper-makers Hirt found an average duration of life of 37.6 years. The people who sort rags are liable to a fatal infectious disease, "rag-sorters' disease" (Hadernkrankheit[1]), which resembles in all respects, and is probably nothing less than, anthrax. No cases have been reported in this country, but, as the importation of rags from abroad is carried on to a considerable extent, no apology is believed to be necessary for calling attention to it. The "wool-sorters' disease," to which attention has recently been called in England, is doubtless similar in its nature.

Millers suffer in a large proportion of cases from pulmonary affections, especially bronchial catarrh and pneumonia. According to Hirt, 20.3 per cent. of all the diseases of these workmen are pneumonias, 9.3 per cent. bronchial catarrhs, 10.9 per cent. phthisis, and 1.9 per cent. emphysema. The average duration of life is 45.1 years. The Massachusetts table gives 57.14 years, —a very much more favorable exhibit.

The laborers in grain-elevators are compelled to inhale a very irritating dust, which causes acute and chronic catarrhs of the respiratory organs. Dr. T. B. Evans, of Baltimore, has reported a series of cases of catarrhal pneumonia in these workmen, which were characterized by some very peculiar features. Brush-making, according to the statistics of Hirt, is a very dangerous occupation. Nearly one-half of the deaths among brush-

[1] See article by Soyka, Realencyclopædie d. ges. Heilk, Bd. VI, p. 165.

makers are from phthisis, due, in great measure, to the inhalation of the sharp fragments of bristles produced in trimming the brushes. In the Massachusetts table the average duration of life is given at 43.11 years.

III.—DISEASES DUE TO THE ABSORPTION OR LOCAL ACTION OF IRRITATING OR POISONOUS SUBSTANCES.

Arsenic is used in the manufacture of green pigments and for various other purposes in the arts. In the preservation of furs and in taxidermy it finds extensive use. In the preparation of the pigment known as Paris green the workmen are frequently entirely covered by a layer of the poisonous salt. The poisonous symptoms occur in consequence of the absorption of the poison through the skin or from its local action, and but rarely on account of inhalation of vapors or dust in which it is contained. The most marked symptoms are chronic gastric catarrh, superficial erosions in the mouth, dry tongue, thirst, and a burning sensation in the throat. These symptoms may continue for months, or even years, and gradually produce a complete breaking down of nutrition and the vital powers. Violent itching skin eruptions of an eczematous character are not infrequent complications of the internal symptoms.

Lewin has described a localized pigmentation of the skin in workmen (engravers) in silver. The left hand is especially affected. The occurrence of the affection is explained by the numerous slight injuries of the hands by the graver's tools and the local absorption and decomposition of the silver.

Phosphorus produces two classes of effects in persons subjected to its influence. The milder effects are produced by the inhalation of the fumes of the substance, and are limited to digestive disturbances and diseases of the pulmonary organs. The severer symptoms are only observed among the employés in match-factories, and are due to the local action of the phosphorus upon the tissues affected.

The characteristic disease produced by phosphorus is a

painful periostitis of the lower or upper jaw. The limitation of the affection to this locality is believed to be due to the action of the phosphorus dissolved in the saliva. The fact that the lower jaw, with which the saliva comes more thoroughly in contact, is most frequently affected seems to indicate that this view is the correct one. The disease begins, on an average, five years after the beginning of the employment. Hirt estimates the proportion of employés in match-factories attacked at 11 to 12 per cent. The first symptom of the disease is toothache, soon extending to the jaw. The cervical glands swell up; the gums become reddened and spongy; abscesses form about the diseased teeth, from which large quantities of thin, offensive pus are discharged. Examination with a sound reveals carious, nodulated bone. The cheeks become swollen, erysipelatous, and may suppurate and discharge pus externally.

Hutchinson has reported a case in which the long-continued internal administration of phosphorus as a medicine produced maxillary necrosis.

The destruction of the soft tissues continues until resection of the jaw is finally undertaken and the disease checked by surgical interference, and removal of the patient from the influence of the pernicious substance.

Dr. J. Ewing Mears reports[1] 16 cases of phosphorus necrosis. He concludes "that the antidotal powers of turpentine have been established, both in neutralizing the effects of the poison upon operatives during their work and also in the treatment of the early stage of the disease. The disease is to be prevented by the adoption of thorough methods of ventilation, stringent rules with regard to cleanliness, and the free disengagement of the vapors of turpentine in all the apartments of factories in which the fumes of phosphorus escape."

In the manufacture of *quinine* a troublesome eczema is caused in about 90 per cent. of the employés. It seems to be due to emanations given off from the boiling solutions. It

[1] Trans. Am. Surg. Association, 1887.

begins with intense itching, followed by swelling and the formation of vesicles, which soon burst and form crusts. There is considerable fever when the swelling is great. It is said that blondes are more frequently affected than those of dark complexion. The disease soon disappears if the work is given up.

The workmen engaged in the manufacture of *bichromate of potassium* are said to suffer from an ulceration of the nasal mucous membrane very similar to that already described as due to the vapors of hydrochloric acid (p. 212). Rapidly spreading, deep ulcers are also said to form if the bichromate comes in contact with abraded surfaces of the skin.

The *strong alkali* handled by tanners frequently produces fissured eczemas of the hands, which are painful and often difficult to cure.

The workmen in *petroleum refineries* frequently suffer from acneiform or furuncular eruptions.

Among glass-blowers, syphilis is frequently communicated by an infected mouth-piece which is used by the men in turn.

IV.—DISEASES DUE TO EXPOSURE TO ELEVATED OR VARIABLE TEMPERATURE OR ATMOSPHERIC PRESSURE.

Cooks and bakers are exposed almost constantly to a high temperature, which produces an unfavorable influence upon health and predisposes them to diseases of various kinds. The Massachusetts table shows that cooks have a much shorter duration of life than bakers, although the statistics of both trades are unfavorable.

The prevailing diseases among cooks and bakers are rheumatism and eczematous eruptions, generally confined to the hands, forearms, and face.

Blacksmiths, founders, and firemen suffer from the intense heat to which they are exposed, in addition to the inhalation of coal-dust, as has already been pointed out. The stokers in the engine-rooms of steam-ships suffer especially from the excessively high temperature to which they are subjected by their occupation.

A form of heart-weakness, described by Levick as "fireman's heart," is prevalent among them.

Sailors, farmers, coachmen, car-drivers, and teamsters are subjected to stress of weather, changes of temperature, and storms. They suffer frequently from rheumatism, acute bronchitis, pneumonia, and Bright's disease. Car-drivers are said also to suffer from painful swelling of the feet, varicose veins and ulcers, and mild spinal troubles.[1]

Sun-stroke is not confined to any class of artisans, but persons who perform very hard labor, especially in a confined atmosphere, suffer most frequently.

The effects of *compressed air* on workmen in tunnels and deep mines has already been referred to.[2] The most serious symptoms occur not when the individual is subjected to the increased pressure, but when the pressure is too rapidly diminished.

V.—DISEASES DUE TO THE EXCESSIVE USE OF CERTAIN ORGANS.

The prevalent belief that the overuse of the intellectual faculties is a frequent cause of mental disease is not borne out by facts. Men and women who perform an amount of mental work regarded by most persons as excessive have, in spite of this, a long duration of life. There are no exact statistics upon this subject, but Caspar, half a century ago, made the following estimate of the average duration of life among professional men: Clergymen live 65; merchants, 62.4; officials, 61.7; lawyers, 58.9; teachers, 56.9, and physicians, 56.8 years. In the table on page 209 the figures are somewhat less favorable, although corresponding in general with those of Caspar. Hence, it is seen that, of professional men, those whose occupation compels the exercise of high mental powers have a higher duration of life than any other class, except farmers and mechanics engaged actively out of doors. Those professional occupations only which necessitate a more or less irregular mode of life and

[1] A. McL. Hamilton in Report New York Board of Health, p. 444, 1873.
[2] Chapter I, p. 12.

frequent subjection to physical exhaustion and dangers from contagious disease, such as the work of physicians and journalists, make an unfavorable showing in the statistics. The proposition may be laid down that it is not mental *activity*, however great, but mental *worry* that tends to the abbreviation of life.

The occupation of a tea-taster is said to produce a peculiar nervous condition, manifested in muscular tremblings, etc., which compels the individual to give up the work in a few years.

Persons who test the quality of *tobacco*, an occupation corresponding to that of tea-taster, are said to suffer from nervous symptoms, which may include amaurosis and other grave affections.

Those persons who are compelled to use their eyes constantly upon minute objects frequently suffer from defective vision. So engravers, watch-makers, and seamstresses are liable to near-sightedness, amaurosis, and irritation of the conjunctiva. Public speakers and singers frequently suffer from catarrhal or even paretic conditions of the throat, which usually disappear on relinquishing the occupation for a time.

Telegraph operators and copyists suffer from a peculiar convulsive affection of the fingers, called "writers' cramp." Cigar-makers are also said to suffer from a similar cramp of the fingers used in rolling cigars. Performers on wind instruments are liable to pulmonary emphysema, on account of the pressure to which the lungs are frequently subjected. Boiler-makers often suffer from deafness, in consequence of their constant existence in an atmosphere in a state of continual violent vibration. The affection is generally recognized as "boiler-makers' deafness." Dr. C. S. Turnbull has reported several cases of "mill-operatives' deafness." Its characteristic is an inability to hear distinctly except during a noise.

VI.—DISEASES DUE TO A CONSTRAINED ATTITUDE AND SEDENTARY LIFE.

It is probable that the large mortality and morbility rate of persons whose occupations keep them confined within doors

are due, next to the defective ventilation, to the constrained attitude which most of them necessarily assume. Thus, carvers, book-binders, engravers, jewelers, printers, shoe-makers, book-keepers, and cigar-makers all have a low average duration of life. It is found, likewise, that many of these artisans suffer most from pulmonary and digestive troubles, among the former being phthisis, and among the latter constipation, dyspepsia, and hæmorrhoids.

VII.—DISEASES FROM EXPOSURE TO MECHANICAL VIOLENCE.

It will be seen, by reference to the table on page 209, that all persons whose occupations involve an intimate contact with machinery, and in the pursuit of which accidents frequently happen, have a short duration of life. Persons liable to these dangers are machinists, operatives in factories, workmen in powder-mills, baggage-masters, brakemen, drivers, engineers, firemen, and other workmen on railroads. Aside from the diseases to which some of these classes are liable in consequence of exposure to variable atmospheric conditions, the grave accidents to which they are so frequently exposed render their occupations extremely dangerous. Brakemen on freight railroads, for example, are classed by insurance companies as the most hazardous "risks," and some companies refuse to take them at all. The table on page 209 tends to confirm the conclusion of the insurance companies, for, excluding the class of "students," which, for manifest reasons, cannot be used as a comparison, brakemen have the shortest average duration of life of all the occupations noted in the table.

[The student is referred, for more complete information on the subjects considered in the foregoing chapter, to the following works:—

L. Hirt, Die Krankheiten der Arbeiter.—Eulenburg, Handbuch der Gewerbehygiene.—Layet, Hygiène des Professions et des Industries.]

CHAPTER X.

Military and Camp Hygiene.

The subjects embraced in this chapter can be most conveniently arranged under the following heads:—

I. The Soldier and his Training.
II. The Food of the Soldier.
III. The Clothing of the Soldier.
IV. The Dwelling of the Soldier.
V. Camp Diseases.
VI. Civilian Camps.

I.—THE SOLDIER AND HIS TRAINING.

The relations existing among different nations at the present time require that a standing army of greater or less number be maintained by each for the common safety. This being the case, it needs no argument to prove that such an army should be composed of the best material available in order that it may be depended upon for defense or offense when necessity demands that it should be called into active service.

Hammond says with truth[1] that "a weak, malformed, or sickly soldier is not only useless but a positive incumbrance" to an army. It is of the first importance, therefore, to exclude from the military service, by a rigorous physical examination, all individuals whose physical condition is defective, who are either suffering from or predisposed to disease.

The foremost authorities on military hygiene are agreed that no recruit should be enlisted for actual service before the 20th year. In the English army the lowest age at present is 19 years; in Germany, 20 years; in France, 20 years for actual service (*recrues*), 18 years for enlistment (*engagés*); and in the United States, 21 years. The limit of age upward in the latter army is 45 years, except in cases of re-enlistments. The height of recruits must be at least 165 centimetres; minimum chest

[1] Hygiene, p. 19. Philadelphia, 1863.

measurement 75 centimetres, with at least 5 centimetres' expansion; and weight from 54 to 81 kilogrammes. In the cavalry service the maximum weight is 75 kilogrammes. Every recruit must be vaccinated before enlistment.

The physical examination of recruits before enlistment must be made by a medical officer, whose decision, in the United States army, is definitive. In the German army the decision of the medical officer is not final, but subject to revision by the recruiting officer, who may, if he sees fit, overrule the medical officer's opinion and enlist a man who has been decided to be unqualified for the military service. In this and various other respects, such as pay, rank, and effective power, the Medical Staff of the United States Army has many advantages over that of most foreign armies.

II.—THE FOOD OF THE SOLDIER.

The army ration of the United States, which is given below, was fixed by regulations before the more-recent researches of Professor Voit on nutrition were completed. The ultimate composition, which yields 142 grammes proteids, 116 grammes fats, and 435 grammes carbohydrates, shows an excess of fats and deficiency of carbohydrates. Table XXI shows the daily allowance for each soldier:—

TABLE XXI.

342	grammes	pork or bacon, *or*
567	"	fresh beef.
454	"	hard bread, *or*
566	"	flour.
68	"	beans or peas, *or*
45	"	rice or hominy.
45	"	green coffee.
17	"	salt.
68	"	sugar.

To this is also added vinegar, pepper, and tea in place of coffee. Although the regular food-allowance in the United States army is liberal, and is largely in excess of the needs of the soldier

in garrison, medical officers generally agree that in active service it is insufficient in quantity and not sufficiently varied.

The money value of each of the above articles in the ration is fixed by the government, and may be drawn instead of certain of the articles, and other articles of food purchased and thus the dietary varied. The money so drawn constitutes what is known as the "company fund." In the hands of a judicious commanding officer, the company fund can be made a source of great benefit and comfort to the men, but that it is at times mismanaged or misapplied is well known to army surgeons.

Aside from the insufficient quantity and variety of food furnished to soldiers, the cooking, especially in temporary camps, is often defective and causes digestive derangements and consequent innutrition. A good cook should be attached to every company.

III.—THE CLOTHING OF THE SOLDIER.

The clothing of the United States soldier is tolerably well adapted to its uses. It is generally well made, and of good, serviceable material. The only exception that can be made with reason is that the foot-gear is not made to individual measure, and hence peculiarities of shape of the feet cannot be taken account of. For this reason painful affections of the feet, due to ill-fitting boots or shoes, are of frequent occurrence.

When on a march, the soldier carries his extra clothing packed in a knapsack and strapped upon the back. His blankets and great-coats are rolled into a cylinder and strapped upon the knapsack. The weight each soldier has thus to carry, in addition to his arms and ammunition, amounts to considerable. There is reason to believe that the pressure produced by the straps of a heavy knapsack may cause not only discomfort but actual disease. It is believed by many officers that the knapsack could be abolished with advantage, and the extra clothing rolled up in the blanket, or a water-proof sheet, and slung over the left shoulder.

IV.—THE DWELLING OF THE SOLDIER.

Soldiers are generally housed either in barracks, huts, or tents. The former are usually the habitation of the soldiers in garrisons or permanent camps, while huts or tents are used for the purpose of sheltering the occupants of temporary camps.

Barracks.—A military barrack is a one-storied building constructed of stone, wood, or iron, or a combination of these materials. The general plan of the barrack comprises a large room for the beds of the soldiers, one or more smaller rooms for the non-commissioned officers of the company or squad, and a wash-room. The sleeping-room of the soldier is also his living- or day- room. It is evident, therefore, that sufficient air-space and good ventilation must be provided if the soldier's health is to be maintained. In England, 17 cubic metres are recommended for the initial air-space. In the new barracks constructed in France according to the plans of M. Tollet, 22 cubic metres are allowed to each occupant.

The special points of distinction of the system of Tollet, of which Schuster says that "to it belongs the future of barrack construction," are: The frame of the building is of light-iron ribs; the interspaces are walled up with bricks or stone; the roof is slate; the ceiling is arched, and all corners are rounded to prevent lodgment of dust. Ventilation is provided by openings in the walls at the edge of the roof for the entrance of fresh air, and by ridge ventilators.

In France, barracks have been built according to Tollet's system at Bourges, Cosne, Macon, and Autun. Although occupied but a short time, it appears that the health of the soldiers remains better in them than in the barracks constructed on the old style. The system would seem also especially to lend itself to the construction of hospitals. The wash- and bath- rooms of the barracks should be so arranged as to encourage the soldier to cleanliness. Where the only lavatory in a barrack is, as the author has seen it, an open porch, men are not likely to

spend much time in cold weather in washing their faces and hands, to say nothing of the rest of their bodies.

The kitchen and dining-room should be detached from the building serving as quarters; otherwise the odors of the cooking will pervade the building.

The sinks or latrines should be placed at some distance from the quarters and kitchen, and out of the line of prevailing winds. The writer has personal knowledge of a permanent military post within a few miles of the city of Washington, where, only a few years ago (and, for aught known to the contrary, at the present day), "the rear," or place of depositing excrement, was about 70 metres distant from the kitchen and men's quarters, and directly in line (to leeward) with the prevailing winds!

Before erecting any buildings it is, of course, necessary to endeavor to secure a clean and dry subsoil. Attention is called to the principles underlying the construction of dwellings, Chap. VI.

Tents and Huts.—The tents used in the army are the hospital-tent, the officers' wall-tent, the $\wedge$-tent, and the shelter-tent, which is a modification of the last. The conical, or Sibley tent, which was frequently seen in camps in the early part of the war between the States, has gone out of use. Soldiers give the preference to the shelter tent, which is light, each man's piece weighing only 1.18 kilogrammes. Two pieces being joined together by buttons and button-holes, and thrown over a ridge-pole supported upon uprights, and the four corners fastened to pegs driven into the ground, form a tent 1.20 metres high, 1.65 metres long, and having a spread at the base of between 1.8 and 2.1 metres. Such a tent will form a comfortable shelter for two men, unless there should be strong winds or driving rains, when the ends could be closed by blankets, brush, or an extra piece of shelter-tent. The uprights and ridge are steadied by short guy-ropes, one of which is furnished with each piece of the tent.

In winter, especially when camps of more or less permanence are formed, the soldiers usually build log huts. The

interstices between the logs are plastered up with mud or clay, and the roof is formed of canvas, generally several pieces of shelter tent joined together.

The ground around the tent or hut should be trenched in order to carry off the rain-fall.

Cleanliness within and around tents or huts is of the first importance, and should be enforced in all camps by the proper authority. Military authorities have long since learned that in the matter of cleanliness of body, clothing, or surroundings voluntary action on the part of the soldier cannot be relied upon. Frequent and thorough inspections will alone secure proper cleanliness.

V.—CAMP DISEASES.

The soldier's profession has been aptly characterized by Ruskin as "the trade of being slain." In the late war between the States, the total deaths of the Federal army numbered 359,496, —over 15 per cent. of the entire number of enlistments. Of this number, however, 224,586 (nearly two-thirds) died from disease, while the remaining 134,910 (a small fraction over one-third) were killed in battle or died from the effects of wounds. The colored troops especially suffered greatly from the effects of disease.

Diarrhœa and Dysentery.—The most fatal diseases of camp life, especially in time of war, are diarrhœa and dysentery. The statistics of the Federal army during the late war are given in the following table[1]:—

TABLE XXII.

Total Deaths from Diarrhœa and Dysentery in the U. S. Army, from May 1, 1861, to June 30, 1866.

	White Troops, from May 1, 1861, to June 30, 1866.		Colored Troops, from July 1, 1863, to June 30, 1866.		Total.	
	Cases.	*Deaths.*	*Cases.*	*Deaths*	*Cases.*	*Deaths*
Acute Diarrhœa	1,155,226	2,923	113,801	1,368	1,269,027	4,291
Chronic Diarrhœa . . .	170,488	27,558	12,098	3,278	182,586	30,836
Acute Dysentery	233,812	4,084	25,259	1,492	259,071	5,576
Chronic Dysentery . . .	25,670	3,229	2,781	626	28,451	3,855
Total	1,585,196	37,794	153,939	6,764	1,739,135	44,558

[1] Medical and Surgical History of the War, second medical volume, p. 2.

Owing to the fact that a considerable number of deaths were reported without assigning any cause, Dr. Woodward estimates the total number of deaths from the above diseases at 57,265, or, in the proportion of one death from diarrhœa and dysentery to three and one-half deaths from all diseases. Among the prisoners of war held by the Confederate States in Andersonville prison, where tolerably complete records were kept, more than half the total deaths were from diarrhœa and dysentery, while the ratio of deaths to cases of the above two diseases was a fraction over 76 per cent. This frightful mortality from these two diseases, both in the prisons and among the armies in the field, is principally due to the insanitary conditions surrounding the soldiers. Where the demands of hygiene were especially ignored; where the food was bad in quality, or badly cooked; the water impure; the soil polluted by excreta and other filth; where the men were exposed to stress of weather or to a paludal atmosphere;—under these conditions, the above diseases of the intestines prevailed in their greatest extent and most fatal degree.

Malarial Fevers.—The diseases due to the paludal poison are exceedingly frequent among soldiers encamped in malarial sections. During the Civil War a very pernicious form of malarial fever received the designation of the locality in which it prevailed, and passed into the literature under the name of "Chickahominy fever." While malarial diseases were largely represented in the morbility reports during the war, the most serious results of the influence of the malarial poison were manifested in its effects upon patients sick with other diseases. Thus, typhoid fever, dysentery, or pneumonia, in a patient saturated with malaria, was very much more serious than where this complication was absent. In the malarial regions in the interior of the country, the Mississippi Valley, and the southern portion of the Western Territories, malarial fevers are among the most prevalent camp diseases. Greater attention in locating camps, and care devoted to draining the subsoil and maintaining a low level of the ground-

water, would doubtless result in improvement in the sickness-rate from this cause in the army.

Typhoid Fever.—Typhoid fever is prevalent in camps and garrisons. As it may be propagated through the medium of infected discharges of typhoid patients, it will readily be perceived that neglect of the precaution of promptly disinfecting such discharges will almost inevitably result in spreading the disease, either by direct inhalation of effluvia from the patient or excreta, of pollution of the drinking-water, or by contamination of the soil, and subsequently of the atmosphere, by the intestinal discharges of the patient.

Phthisis.—Especially among troops in barracks phthisis is a very fatal disease. Formerly the mortality from it was very heavy. Recent improvements in the hygiene of military posts and greater care in selecting recruits have very greatly diminished the death-rate from phthisis among soldiers. Acute pulmonary affections, such as bronchitis, pleurisy, and pneumonia, are comparatively frequent in camps, being due to exposure.

Typhus Fever and Scurvy.—These two diseases are at the present day comparatively rare as camp diseases. They break out, however, on every occasion when the laws of hygiene are violated by permitting overcrowding, overwork, and underfeeding. This is almost certain to occur during war, and hence either fully-developed scurvy or a scorbutic taint are almost constant accompaniments of an army in the field. Among the allied armies in the Crimea, and in the Federal army during the war, scurvy and typhus fever claimed a considerable share in the mortality.

Purulent Conjunctivitis.—This affection of the eyes is frequent among soldiers. It has even been supposed to be peculiar to soldier life, and has hence been termed "military ophthalmia." It is contagious, and is probably most often spread by the use of basins and towels in common. It is not merely annoying, but is a very grave affection, often causing perforation of the cornea and destruction of vision. The military surgeon should be on the lookout for it, and promptly isolate those infected.

Venereal Diseases.—The contagious diseases of the sexual organs are a veritable scourge of the soldier's life. The history of these diseases is intimately interwoven with the history of armies, camps, and wars. The first wide-spread appearance of syphilis in the fifteenth century is coincident with the siege of Naples by the French army under Charles VIII.[1] It has since that time been a constant companion of the soldier in peace or war, and in all seasons and countries. Some progress toward its restriction has, however, been made in recent years in certain localities, but there is still wide room for improvement.

In 1867 the venereal diseases reported in the Prussian army were 53.9 per 1000 of mean strength. In 1882 this number had been reduced to 41 per 1000, in 1863 to 36.4, and in 1884 to 32.8 per 1000. In the Austrian army there were 81 per 1000 in 1870, diminishing to 73.5 per 1000 in 1884. In the British army the ravages of the venereal diseases were so terrible that legal measures for their restriction by subjecting prostitutes to inspection were taken. In 1859 the proportion of venereal disease among the home troops was 400 per 1000. In 1864 and 1866 the passage and enforcement of the "Contagious Diseases Act" caused a marked diminution of these diseases. This reduction is particularly noticeable in syphilis. The following table gives a comparative view of the number of cases of syphilis per 1000 in the naval service at ports under the acts, and at ports where the acts were not enforced:—

TABLE XXIII.

	Ports Under the Acts.	Ports Not Under the Acts.
1860–1863 (no restriction),	75.02 per 1000	70.50 per 1000
1864–1865 (acts enforced),	79.12 " "	100.00 " "
1866–1870 (acts extended),	47.19 " "	84.74 " "
1871–1880, ...	40.64 " "	99.35 " "

In the French army the proportion of venereal diseases was 53 per 1000 from 1862 to 1866. In 1867 the proportion increased to 106 per 1000. This increase was attributed to the

[1] See article on Syphilis, Chapter XIX.

infection during the Mexican campaign. In 1879 the proportion had again diminished to 65.9 per 1000.

In the United States Army the venereal diseases numbered 63 per 1000 among the white and 81 per 1000 among the colored troops in 1884. A chart drawn by Major Charles Smart, surgeon United States army,[1] shows in an interesting manner how opportunity for infection influences the increase of venereal disease. At the breaking out of the war, when large numbers of men enlisted, the record shows a rapid increase of venereal. When the armies were in the field, and opportunities for the pursuit of Venus were few, the proportion of venereal decreased. At the expiration of the first triennial period of enlistment, the soldier with his final pay and thirty days' furlough crowded the cities, and entered on a period of dissipation which usually sent him back to the recruiting officer with empty pockets and an attack of gonorrhœa or syphilis. At this time the records show a large number of cases, which gradually diminished until the end of the war, when the opportunities for infection preliminary to the final muster-out crowded the hospitals once more with venereal cases.

The experience with the Contagious Diseases Act in England points out the true way to limit or entirely extirpate this disease among the military and naval forces. An inspection at regular intervals not only of public prostitutes, but also of the soldiers themselves, and segregation of the infected in hospitals until the infective period is past, will do more to limit the spread of venereal disease than all other preventive measures, public or private, put together.

VI.—CIVILIAN CAMPS.

The camps of civil life, whether established for the purpose of furnishing a refuge to the inhabitants of cities invaded by epidemic diseases, as yellow fever or cholera, or whether for religious purposes (camp-meetings), or for recreation (hunting

[1] Medical and Surgical History of the War, third medical volume.

and fishing camps, etc.), should be organized and managed on the same principles as the military camp. The site should be selected with judgment—a clean, dry soil, and abundance of wood and water being requisite for a healthy camp. A superintendent or officer of the day should be appointed, whose duty it is to carefully inspect the camp daily, and compel the prompt removal of all filth and offal from the immediate vicinity. Cleanliness of person, clothing, and household is as important while "roughing it" in camp as at home. Singularly, this is very often forgotten by very intelligent people.

The advantage of a well-administered refugee camp in case of yellow-fever epidemics has been clearly shown by the brilliant success of the depopulation of Memphis during the epidemic of 1879 and of various Florida cities and towns in 1888. These experiments deserve imitation.

[The following works on Military and Camp Hygiene should be studied in connection with this chapter:—

Smart, The Hygiene of Camps, in Buck's Hygiene and Public Health, vol. ii.—Wolzendorff, Armee Krankheiten, in Realencyclopædie d. ges. Heilk., Bd. I, p. 489.—Schuster, Kasernen, in von Pettenkofer und Ziemssen's Handbuch der Hygiene, II Th., 2 Abth.—Cameron: Camps, Depopulation of Memphis, Epidemics of 1878 and 1879. Public Health, vol. v, p. 152.—Frölich, Militärmedicin.—Medical and Surgical History of the War, especially the second and third medical volumes. —Annual Reports of the Supervising Surgeon-General of the United States Marine Hospital Service, 1888–9.]

CHAPTER XI.

Marine Hygiene.

The melancholy accounts of the mortality from scurvy, dysentery, and typhus fever, which were formerly a part of the history of so many naval and passenger vessels, are happily now only records of the past. Occasionally, however, carelessness of the authorities, or of those responsible for the safety of people who "go down to the sea in ships," results in an outbreak of one or other of these diseases even at the present day. Thus, for the fiscal year ending June 30, 1882, 71 cases of scurvy and purpura were reported by the medical officers of the Marine Hospital Service. It appears that only in one instance (where 6 cases of scurvy had occurred on one vessel) was any investigation ordered. A most superficial investigation showed that the law relating to the issue of lime-juice had been violated by the master of the vessel. No prosecution resulted. Such facts indicate that laxness in the enforcement of the regulations expressly made to prevent this fatal disease may be again followed by outbreaks of greater or less gravity.

I.—THE SAILOR AND HIS HABITS.

Although the sailor of the present day, especially in the naval service, is morally and intellectually far in advance of the "Jack Tar" of former days, his life, both afloat and on shore, leaves much to be desired on the score of temperance, chastity, and purity of thought and speech. The life of a sailor in the United States navy, only thirty years ago, is thus graphically described by Medical Director Albert L. Gihon[1]: "She was manned by a motley crew, of whom Americans were a minority,

[1] Thirty Years of Sanitary Progress in the Navy: Annual address by the President to the Naval Medical Society, Washington, 1884.

and Englishmen, Irishmen, Northmen, and 'Dagos' constituted the far greater part. Some had just returned from another cruise, having squandered or been robbed of their three years' pay by the landsharks, who cajoled them, only half sober, to the rendezvous, to be reshipped, and thence to be herded, uncared for, on the receiving-ship, still popularly termed the 'guardo,' until drafted on board the first sea-going vessel. All of them were in debt, most of them insufficiently clad, and unable to properly outfit themselves. The wretched herd, who were thus gathered from the purlieus of Water Street, and North Street, and South Street, who at night were kenneled worse than dogs, by day fed like them—crouching on their haunches around greasy mess-cloths, cutting with jack-knives or pulling to pieces with grimy fingers the chunks of 'salt horse' and 'duff' which made their daily fare, and which later in the cruise were both spoiled and scanty, did not constitute an elevating subject for contemplation.

"Stint of good food," continues Dr. Gihon, "was, however, not the chief of the old-time shell-back's ocean trials. Fed like a brute, housed worse than one, however faithfully his labors were performed, there was for him only a long, dreary season of imprisonment. For him there was no glad holiday on shore, when the land broke the monotony of the waste of waters. The officers might rush pell-mell out of the ship, but Jack could only strain his longing eyes upon the green fields or busy seaports. Notwithstanding the hardships of the voyage, the wretched food, and the outbreaks of disease, the crew were confined eight months on board ship, before 'general liberty' was given, and then men and boys were sent on shore for forty-eight hours to indulge in a mad revel, and to return crazed by rum, battered, and bruised. The poor wretch, first made ravenously hungry for dissipation by his enforced confinement, was then expected to be temperate in the feast of indulgence offered him, and punished with vindictiveness if he sought to gorge himself with the poor semblance of pleasure. The 'cat' had been

abolished, but half a dozen boys strung upon the poop 'bucked and gagged'; half a dozen men triced up by their thumbs in the rigging; each of the upright coffin-like 'sweat-boxes' with its semi-asphyxiated inmate; the 'brig' with its bruised and bloated crew in irons; the main-hold with its contingent under hatches; the sick-list swollen out of all proportions by inebriates, injured men, and venereal cases;—these were the fruits of the general liberty, which, within my professional life, represented the sum of sanitary interest in the man before the mast."

Under such circumstances little could be hoped for in the way of personal advancement of the crew. The labors, however, of the writer just quoted, and others, among whom may be mentioned Wilson and Turner, of the navy, and Woodworth, Hebersmith, and Wyman, of the Marine Hospital Service, have drawn prominent attention to the unsanitary conditions of the sailor's life, and legal enactments have done much to elevate him to his proper rank as a human being, entitled to be treated with humanity, at least.

The seaman in the navy is now well clad, and receives an abundance of food, of good quality, usually well cooked and decently served. "Latrines and bath- and wash- rooms under the top-gallant forecastle; mess-tables and benches; mess-lockers and clothes-lockers; a place where, and opportunities when, men can read and write; and frequent daily liberty to go on shore, if not already common to every vessel, are yet now so generally the concomitants of the well-officered and well-disciplined and efficient ship, that ere long their absence will be accounted a fault."[1] A medical corps, selected after the most rigorous examination known to the profession, and provided with every aid and appliance of medical science, cares for the enlisted sailor and marine when ill or injured, as tenderly as for the commissioned officer.

The sailor in the merchant service, however, is still at the

[1] Thirty Years of Sanitary Progress in the Navy, Gihon.

mercy of inhuman masters, who exact excessive service in return for insufficient food, scanty clothing, miserable lodging, abuse, ill-treatment, and neglect when sick or disabled.

II.—THE PASSENGER.

During the ten years from 1870 to 1879, inclusive, passenger vessels carried 1,561,126 passengers from foreign ports *en route* to New York City. The mean duration of each voyage was 13.5 days. Out of the above number of passengers 2518 died on the voyage,—a death-rate of 1.61 per 1000 for the voyage and 43.5 per 1000 per annum. These figures accentuate the importance of sanitary improvement in passenger vessels. The causes of this excessive mortality among emigrants—for it is almost exclusively among the passengers in the steerage, or "between decks," that the deaths occur—are overcrowding, improper feeding, defective ventilation, filthy personal habits, and inefficient medical attention when sick. Although overcrowding is prohibited by statute, yet in every emigrant vessel that arrived in New York during the first nine months of 1880 the number of passengers was in excess of the number allowed by law.[1] The shorter voyages and better sanitary conditions obtainable since steamships, especially those built of iron, have come into general use for the carriage of passengers, have very much reduced the mortality on ocean voyages; but, as just shown, the death-rate is still excessively high, and many more improvements in the hygiene of emigrant vessels and of passengers are desirable.

III.—THE SHIP AS A HABITATION.

As a habitation for the sailor and passenger the ship demands the attention of the sanitarian. The principal points in which he is interested are the construction and ventilation of sleeping-apartments, and the means of keeping the entire ship clean and free of water and impure air.

The keel is the foundation of the ship. Branching out

[1] Hygiene in Emigrant Ships, Turner, Public Health, vol. vi, p. 24.

transversely from it are curved timbers, the ribs, which, with the keel, constitute the ship's frame. The ribs are covered externally and internally with planking, and the spaces between the two coverings are the frame-spaces, which are usually partly filled with filthy water, decomposing organic matter, and foul air. The water collects in the bottom of the vessel, the bilge,[1] whence it is pumped out of the vessel. If the pumping is neglected the bilge-water becomes very offensive, and may cause disease in persons exposed to exhalations from it. The frame-spaces are rarely ventilated, and hence are frequent sources of pollution of air on board vessels.

The sleeping-apartments of the crew of a merchant vessel are in the forecastle, usually a small, dark, damp, filthy, unventilated space in the bow of the vessel, where they are kenneled like brutes. On naval vessels the crews sleep on the berth-deck, which, in the rarest instances, is properly lighted and ventilated. The berth-deck is usually below the water-line. In nearly all and even the best class of vessels in the United States navy the air-allowance for each man is less than 3 cubic metres, rarely reaches 4, is oftener from 2 to $2\frac{1}{2}$, and is sometimes as low as 1 cubic metre. The men swing by night in hammocks suspended from the beams overhead, and removed when not in use, carried on deck, and stored in lockers, called "hammock-nettings," on the ship's sides.

That a ship should, above all, be *seaworthy* would seem to require no argument. It is self-evident that a leaky or rotten ship is at all times a highly dangerous habitation, yet crews and passengers are almost daily exposed to the perils of shipwreck in unseaworthy vessels, especially in the mercantile marine.[2]

"Dampness, dirt, foul air, and darkness," according to Gihon, "are the direst enemies with which the sailor has to battle when afloat."[3] The first requisite for a healthy ship is

[1] Hence called "bilge-water."

[2] The Safety of Ships and Those who Travel in Them, Woodworth, Public Health, vol. iii, p. 79 *et seq.*

[3] Naval Hygiene, 3d ed., p. 28.

dryness. "A damp ship is an unhealthy ship," says Fonssagrives, the greatest authority on naval hygiene. From official reports it appears that the relative humidity of the berth-deck of vessels in the United States navy is nearly always above 80 per cent., very often rising to 90 and 95 per cent.[1] From the same source it is learned that the class of respiratory diseases furnished, with one exception, the largest amount of sickness in the navy during the year 1880. It is the concurrent testimony of all authorities in marine hygiene that the vicious custom of daily drenching the decks with water, under the plea of cleanliness, is mainly responsible for this excessive moisture and its results. The battle of naval hygiene was long fought on this contested field of wet decks, until the fact became so patent that wet ships were always unhealthy ones. It is, therefore, one of the most important aims of marine hygiene to curtail this practice.

Gihon recommends that the decks be painted and then coated with shellac, occasionally renewed, to make them non-absorbent, and to wet them as rarely as possible, consistent with cleanliness, the smooth surface of the shellacked deck being quickly swabbed over with hot water and thoroughly dried.

The ship should be *clean and well ventilated.* Efforts to keep a ship clean should not be expended upon the decks only; the occupied apartments below the hatches, the bilges and frame-spaces should all receive especial attention from the sanitary inspector.

It is quite frequently necessary to remove the flooring of the vessels in order to expose the accumulations of filth, which often make an infected ship synonymous with a dirty ship. An unobstructed passage, to which ready access can be had through removable covers, should extend under the flooring from one end of the vessel to the other. To disinfect a dirty ship, steam forced into the hold under pressure, before and after the filth has been cleaned out, gives the most satisfactory results.

[1] Report of Surgeon-General of the Navy, Washington, 1880.

Fumes of sulphur burned in the presence of watery vapor, and chlorine are next in efficiency.[1] Solutions of sulphate of iron or chloride of zinc may be poured into the bilges to prevent decomposition.

It has been estimated[2] that a minimum of 15 cubic metres of air-space, with facilities for thorough ventilation, should be allowed to each person on board ship. It is safe to say that no vessel that floats gives to her passengers or crew the advantages of such conditions. Ventilation of the holds and bilges, and of the spaces between the timbers or ribs, "intercostal ventilation," as Turner calls it, is especially necessary. Any system of ventilation that does not contemplate the removal of the foul bilge-air is unworthy of consideration by the sanitarian. The ventilating apparatus which has been introduced on board vessels of the United States navy consists essentially of two longitudinal mains extending through the holds and under the engines, boilers and coal-bunkers the entire length of the ship, beginning in contracted extremities at bow and stern and terminating in a chamber or "blower-room" on the berth-deck just forward of the mainmast. In this room a Sturtevant fan or blower, 2 metres in diameter, is driven by an engine at from 150 to 300 revolutions a minute, expelling the air through a 70-centimetre funnel, opening high above the spar-deck. Small metal pipes connect these longitudinal mains with every state-room, store-room, pantry, and other inclosed apartment on the berth-deck, orlop, and holds, from which the foul air is aspirated by the revolution of the fan.

Fresh air finds its way below through the wind-sails, ventilating-shafts, hatchways, and air-ports, entering the apartments by way of doors, crevices, and other natural apertures. Similar small metal pipes also connect the bilges with the longitudinal mains, and air is thus drawn through the frame-spaces between the timbers, which terminate below at the floor of the

[1] Report of Committee on Disinfectants, American Public Health Association.
[2] Hygiene of Emigrant Ships, Public Health, vol. vi, p. 26.

ship and open above on the spar-deck, and a circulation of fresh air is thus established in the frame or "skin" of the ship, contributing greatly to its dryness and to the preservation of the material of the vessel. The absolutely essential condition of this system of ventilation is that the blower shall revolve, but, unfortunately, sanitary interests are too often sacrificed on the pretext that economy of fuel will not permit the operation of the fan.[1]

All parts of the vessel used as habitations or sleeping-apartments should receive sufficient sunlight. At present, very few vessels have the quarters of the crew so disposed as to admit any sunshine at all.

In the fire-rooms of steamships, especially on that class of naval vessels termed monitors, the temperature often rises so high as would seem to render continued existence in it impossible. Gihon states that the average temperature in the fire-room of the monitor *Dictator* was 145° F. (63° C.), while Turner states that in another vessel the average fire-room temperature was 167° F. (75° C.).[2] The firemen and coal-heavers (stokers) frequently suffer from heat-stroke, and, in a very large proportion of cases, from heart disease.

Lavatories and bathing facilities should be furnished on vessels for passengers and crew, and both should be compelled to keep their bodies and clothing clean. A more liberal supply of water for drinking, a more frequent issue of fresh meat and vegetables, and better cooking are the sanitary considerations to-day in the subsistence of the sailor. The American naval ration is superior in variety and palatableness to that of any foreign service, but skilled cooks are still a desideratum on board men-of-war, and medical officers have long been insisting that schools for their instruction should be established at recruiting stations. The composition and distribution of the rations are given in the following table:—

[1] Hygiene (Naval), Hand-book of the Medical Sciences, Gihon.
[2] Buck's Hygiene and Public Health, vol. ii, p. 190.

TABLE XXIV.

ALLOWANCE FOR GENERAL DAILY USE.

(Either one of the following.)

Rations Established by Law.	Specified by Law.	Substitutes Authorized by Law.
Ration No. 1	1 lb. salt pork	1¼ lb. fresh meat; or, ¾ lb. preserved meat.
	½ pint beans or peas	Vegetables of equal value; or, ½ lb. rice.
Ration No. 2	1 lb. salt beef	1¼ lb. fresh meat; or, ½ lb. preserved meat.
	½ lb. flour	
	2 ozs. dried fruit	Vegetables of equal value.
Ration No. 3	¾ lb. preserved meat	No substitute.
	½ lb. rice	½ pint beans or peas.
	2 ozs. butter	No substitute.
	[1] 1 oz. desiccated mixed vegetables	6 ozs. canned vegetables.
Ration No. 4	¾ lb. preserved meat	No substitute.
	2 ozs. butter	No substitute.
	[1] 6 ozs. desiccated tomatoes	6 ozs. canned tomatoes.

DAILY ALLOWANCE.

Rations Established by Law.	Specified by Law.	Substitutes Authorized by Law.
Ration No. 1	14 oz. biscuit	1 lb. soft bread. 1 lb. flour. ½ lb. rice.
Ration No. 2	½ oz. tea	2 ozs. coffee. 2 ozs. cocoa.
Ration No. 3	4 ozs. sugar	For coffee and sugar, extract of coffee combined with milk and sugar may be substituted by the Secretary of the Navy, if not more expensive.

WEEKLY ALLOWANCE.

Rations Established by Law.	Specified by Law.	Substitutes Authorized by Law.
Ration No. 1	[2] ½ pint pickles	None.
Ration No. 2	½ pint molasses	None.
Ration No. 3	½ pint vinegar	None.

[1] These articles being out of the market, and not procurable, the nearest possible substitutes are given.

[2] One-half pint of pickles is considered equal to ½ lb., and is issued as such.

IV.—DISEASES ON SHIPBOARD.

The diseases most liable to attack persons on shipboard are: Diseases of the respiratory organs, rheumatism, malarial diseases, digestive disorders, scurvy, typhus fever, and skin diseases; and, where the infection has been conveyed to the vessel by other persons or by fomites: yellow fever, cholera, small-pox, and venereal diseases. It is interesting to note in the last-published report of the Surgeon-General of the Navy that, among a total of 8550 admissions of sick and disabled officers and men of the Navy and Marine Service, nearly 90 per centum were included in the following classes, to wit:—

Casualties,	1917
Affections of the respiratory tract,	1149
Venereal diseases,	1071
Malarial and other fevers,	888
Diseases of the integument,	888
Rheumatism,	521
Affections of the nervous system,	489
Diarrhœal maladies,	483

The remaining 1144 were distributed over a wide range of titles, of which many, as adynamia, cephalalgia, constipation, odontalgia, etc., have no special pathological significance. It is probable that only about one-fourth of the cases of disease occurring at sea are attributable to any of the circumstances of oceanic life, and these are almost entirely inflammatory affections of the air-passages and intestinal tract, neuroses, including nausea marina, and rheumatism.[1]

Most of these affections can be prevented by proper measures of hygiene, as demanded by the conditions described in this chapter or by the enforcement of the following regulations:—

Inspection of crews and passengers should be made compulsory before shipment. Persons suffering from contagious or infectious diseases should not be taken on board.[2] In order to

[1] The Therapy of Ocean Climate, Gihon, Transactions of American Climatological Association, 1889.

[2] Gihon relates an instance where a man suffering from parotitis was transferred from the hospital of a receiving-ship to a vessel going to sea. The disease was communicated to more than seventy of the crew of the latter vessel.

make this provision effective, the history of the individual for two weeks prior to his application for shipment should be known to the inspecting officer. Passengers should possess bills of health from the local authorities at their homes, in order that the presence or absence of such diseases as small-pox, yellow fever, cholera, or plague may be established by the inspector. Cholera has always been introduced into this country by immigrants. Everybody admitted to the ship should be vaccinated. During several years past a number of epidemics of small-pox have been traced to foreign immigrants who had not been properly vaccinated.

Sailors in the merchant service should, like those in the navy, be submitted to a close personal inspection, and those suffering from venereal diseases should be rejected. The usual history of the cases is that they soon go on the sick-list, and thus become an incumbrance instead of an aid on the vessel. Statistics show that 1 man in every 7 or 8 in the naval service and 1 in every 4 of the crews of merchant vessels are affected with some form of venereal malady.[1] These inspections should not be restricted to examinations for venereal diseases, but individuals incapacitated for the performance of a seaman's duties by any cause should be rejected. This precaution would unquestionably reduce the number of marine disasters directly traceable to deficiency in the working force on board vessels. In this country the services of the medical officers of the Marine Hospital Service might be made available to carry out these inspections.

All sailors are liable to be placed in positions where the prompt and accurate distinction of colors becomes necessary, hence all color-blind individuals should be rejected as seamen. The inability to distinguish colors has often been the cause of grave accidents at sea. Pilots can no longer obtain a license unless they satisfactorily pass an examination with reference to their ability to distinguish colors.

[1] The Prevention of Venereal Diseases, Gihon, Public Health, 1882.

[The following works contain more detailed information upon the subject treated in the foregoing chapter:—

A. L. Gihon, Practical Suggestions in Naval Hygiene, 3d ed., Washington, 1873.—T. J. Turner, Hygiene of the Naval and Merchant Marine.—Buck's Hygiene and Public Health, vol. ii.—Walter Wyman, Hygiene of Steamboats on the Western Rivers.—Report of Supervising Surgeon-General M. H. Service for 1882.—Annual Reports of the Surgeon-General of the Navy for 1879, 1880, and 1881.—Various papers by J. M. Woodworth, A. L. Gihon, T. J. Turner, Hebersmith, and A. N. Bell in Public Health, vols. i, iii, and vi.—Hygiene, Naval, by Albert L. Gihon, M.D., in Reference Hand-book of Med. Sciences.]

CHAPTER XII.

Prison Hygiene.

Although the frightful mortality which formerly seemed a necessary accompaniment of the life of the convict has in the past half-century markedly diminished, the death-rate among prisoners is still very greatly in excess of that of persons of the same age in a state of liberty.

The observations and labors of John Howard, the self-sacrificing philanthropist, in the latter half of the last century, and of Elizabeth Fry, in the first half of the present, directed the attention of legislators to the necessity of reform in the conduct of prisons and the treatment of prisoners. As a consequence of the labors of these reformers, the principles of prison discipline have been more fully developed during the past forty years by students of social science everywhere, and certain propositions have been formulated, which govern, to a greater or less degree, legislation upon this subject. These propositions are, briefly, as follow:—

Prisoners must be properly classified according to the nature of their crime and the duration of imprisonment.

The two sexes must be strictly separated, and no opportunity given for intermingling while in the prison.

Female prisoners should have female attendants exclusively. Male watchmen or other attendants should not be allowed in the female department of a prison.

All prisoners must be kept employed at some manual labor, not necessarily for profit, but as an agency in the moral reformation of the convict.

Punishments for infractions of discipline must not be excessive.

Efforts should be constantly made tending to the reclamation of criminals from their life of sin and crime.

Due care must be taken by the State to preserve the health and life of the prisoner whom the State has deprived of liberty and the opportunity of taking care of himself.

A proper classification of prisoners, according to the degree of their criminality, the nature of the crime of which they have been convicted, or the length of time for which they have been sentenced, is now insisted upon by all students of prison discipline. As this subject more nearly concerns the social or legal relations of prisoners rather than their sanitary interests, it is here passed over with a mere mention.

The separation of the sexes, necessity of female attendants on prisoners of the same sex, employment of prisoners, and moral reformation of criminals likewise belong especially to the social aspects of the question, and can find no discussion in this place.

Regarding the remaining proposition, however, that which demands that the State shall exercise due care over the prisoner's health, it comprises a question that demands consideration in a text-book on hygiene.

There is now a general concurrence of opinion that the State, in depriving any person of liberty, has no right to subject the individual suffering such deprivation to any danger of disease or death. In other words, the State has no right to abbreviate the life of the convict sentenced to prison. This proposition requires that the State see to it that the prisoner is well fed, well clothed, and well housed; that he shall be well cared for when sick, and that when his term of imprisonment expires he shall be set at liberty, with only such effect upon his normal expectation of life as would result from the ordinary wear and tear of life upon his health.

It must be confessed, however, that the State is very far short of attaining this object. The mortality of convicts, even in the best-regulated prisons, where especial attention is paid to the sanitary requirements of such buildings, is three times as

great as among workmen in mines, confessedly one of the most dangerous occupations. If insurance companies desired to insure the lives of prisoners, the companies would be obliged, in order to secure themselves against loss, to make the premium equivalent to an advance in age of twenty years. This means that a free person has as long an expectation of life at 40 years as a prisoner has at 20. Attention is again called to the fact that the conditions in the most favorably situated and liberally managed prisons only are here considered. What the results are in other institutions, less favorably constructed and managed, will be apparent from the following brief statement: Mr. George W. Cable has shown [1] that in some of the prisons in the Southern States, under the vicious lease system, the mortality is eight to ten times greater than in properly constructed and managed prisons elsewhere. In Louisiana, for example, 14 per cent. of all the prisoners died in 1881; and in the convict wood-cutting camps of the State of Texas one-half of the average number so employed during 1879 and 1880 died.

The mortality of prisoners is greatest in the second, third, and fourth years of their confinement. In Millbank Prison, in England, the death-rate per 1000 was 3.05 in the first year, 35.64 in the second, 52.26 in the third, 57.13 in the fourth, and 44.17 in the fifth years of imprisonment.

The diseases most frequent among prisoners are pulmonary phthisis and diseases of inanition, manifested by general dropsy. Consumption furnishes from 40 to 80 per cent. of all deaths. When prisoners are attacked by acute febrile or epidemic diseases (small-pox, cholera, dysentery), the mortality is much higher than among persons in a state of liberty. This fatality is due to an anæmic or cachectic condition, which has been called "the prison cachexia,"—a depravement of constitution which yields readily to the invasion of acute diseases.

Prisons should be built upon a healthy site, be properly heated and ventilated, have an abundant water-supply, and

[1] Century Magazine, February, 1884.

be supplied with facilities for a prompt and thorough removal of sewage. Baths and lavatories should be conveniently arranged in order that thorough cleanliness can be enforced.

The problem of feeding prisoners requires careful study. The food should not only be sufficient in quantity and of good quality, but it should be well cooked, and the bill of fare varied often in order to avoid creating a disgust by an everlasting sameness. Prisoners often suffer from nausea and other digestive derangements, brought on solely by the monotonous character of the daily food.

In workshops and sleeping-rooms, dormitories or cells, the cubic air-space allowed to each inmate should not be less than 17 cubic metres, with proper provision for ventilation. The use of dark or damp cells as places of confinement is a relic of the barbarism in the treatment of convicts against which John Howard raised his voice so effectively in the last century. An abundance of sunlight should be admitted into every room in which a human being is confined.

An important hygienic measure is daily exercise in the open air. It should be regularly enforced, and its modes frequently varied in order that it may not degenerate into a mere perfunctory performance.

Punishment for infractions of the prison discipline should be inflicted without manifestation of passion, and only under the immediate direction of some official responsible to the State. It is questionable whether physical punishments, such as whipping, tricing up by the thumbs with the toes just touching the floor, bucking and gagging, and similar barbarities should be permitted under any condition. The permission to exercise such power is extremely liable to be abused by officials. The system of leasing out prisoners to private parties, which prevails in some of the southern United States is vicious in the extreme, because it places the convict under the control of persons not responsible to the State, and, in the majority of instances, morally unfitted to wield the power of inflicting punishment.

[The following works on prison hygiene and prison reform are recommended to the student:—

A. Baer, Gefängniss-Hygiene, in von Pettenkofer und Ziemssen's Handbuch der Hygiene, II Th., 2 Abth.—Trans. International Penitentiary Congress, London, 1882.—Trans. National Prison Association, Baltimore, 1872.—G. W. Cable, The Convict-Lease System in the Southern States, Century Magazine. February 1884.]

CHAPTER XIII.

Exercise and Training.

The healthy functions of the bodily organs can only be maintained by more or less constant use. A muscle or other organ that is unused soon wastes away, or becomes valueless to its possessor. On the other hand, trained use of the various organs makes them more effective for the performance of their functions. Thus, by practice, the eye can be trained to sharper vision, the ear to distinguish slight shades of sound, the voice to express varying emotions, the tactile sense to accurately appreciate the most minute variations of surface and temperature, and the hand to greater steadiness or the performance of difficult and complex feats. The effectiveness of other organs, muscles, or groups of muscles can also be increased by systematic training, as is seen in the athlete and gymnast.

PHYSIOLOGICAL EFFECTS OF EXERCISE.

When a muscle contracts, the flow of blood through it is increased. Hence, contraction of a muscle, which consumes or converts stored-up energy, at the same time draws upon the circulation for a new supply of food-material to replace that consumed. The activity of the circulation through a muscle in action results in increased nutrition and growth of the muscle.

During muscular action the activity of the respiratory process is increased. A larger quantity of air is taken into the lungs, more oxygen is absorbed by the blood, and an increased elimination of carbon dioxide takes place. The experiments of Pettenkofer and Voit show that, while in a state of rest the average absorption of oxygen in twelve hours amounted to 708.9 grammes, during work the amount reached 954.5 grammes.

For the same period the elimination of carbonic dioxide was: during rest, 911.5 grammes; during work, 1284.2 grammes.

Upon the circulation muscular exercise likewise exerts a manifest influence. The action of the heart is increased both in force and frequency, the arteries dilate, and the blood is sent coursing through the system more rapidly than when the body is at rest.

Cutaneous transpiration is also promoted by muscular exercise. It is probable that in this way some of the effete matters in the system are removed, being held in solution and carried through the skin in the perspiration.

PHYSICAL TRAINING.

There can be no question that systematic training of the muscles has a favorable influence upon health and longevity. Persons who are actively engaged in physical labor, other things being equal, are healthier, happier, and live longer than those whose occupation makes slight demands upon their muscular system. In default of an active occupation the latter class is forced, if good health is desired, to adopt some form of exercise which will call the muscles into activity.

The principal methods of physical training are walking or running, rowing, swimming, and the various in-door gymnastic exercises. Rapid walking or running is one of the best methods of physical exercise, for, not only are the muscles of the legs and thighs developed, but the capacity of the chest is increased—one of the principal objects of physical training. By combining walking with some form of in-door gymnastics, such as practice with dumb-bells, Indian clubs, rowing-machines, or pulley-weights, nearly all the good effects of the most elaborate system of training can be obtained.

For the gymnastic exercises various forms of useful labor may be substituted with advantage, such as wood-chopping or sawing, or moderate work at any physical labor.

The scheme of studies in our public-school system should

include physical training for both sexes. This is a question not merely of individual, but of national importance. Weak and unhealthy children are not likely to grow up into strong and healthy men and women; and the latter are necessary for the perpetuity of the nation. The time seems to have arrived when physical education should no longer be looked upon as a whim of unpractical enthusiasts and hobby-riders, but as an indispensable element in every school curriculum.

There is a tendency among instructors in physical training to make their systems too complicated, or dependent upon expensive or cumbersome apparatus. This is to be deprecated. All the muscles of the body can be called into action by very simple exercises, easily learned and readily carried out.

An important preliminary to all methods of training is a thorough physical examination of the pupil by a competent physician, in order to determine whether certain exercises are allowable. For example, in all organic heart affections exercises of a violent character must be interdicted. A boy or man with valvular disease of the heart cannot run, row, or swim with safety. The organ is easily overtasked in this condition and liable to fail in its function.

One of the simplest and best methods to cause the pupil to assume a correct position of the body, and to acquire ease and grace in his movements, is to teach him the "setting-up," as practiced in the United States army.[1]

In walking, a free, swinging step should be acquired, with the head erect, shoulders thrown back, and chest well to the front, the whole body from the hips upward inclining slightly forward. The clothing should be loose around the upper part of the body, in order not to interfere with the freest expansion of the chest, and to give the lungs and heart ample room for movement. Even in-door gymnastic exercises alone, when practiced under intelligent provision, will accomplish very favorable results, as shown by the following table:—

[1] Upton's Infantry Tactics. School of the Soldier, Lesson I.

TABLE XXV.

Showing Average State of Development on Admission to Gymnasium; Average State of Growth and Development after Six Months' Practicing Two Hours a Week, and Average Increase During that Time. (Bowdoin College Gymnasium, under Dr. D. A. Sargent. Two Hundred Students from the Classes of 1873 to 1877, inclusive. Average Age, 18.3 Years.)[1]

	On Admission.	After Six Months' Practice.	Average Increase.
Height	170. cm.	170 6 cm.	.6 cm.
Weight	60.7 kg.	61 6 kg.	900. gms.
Chest (inflated)	87.5 cm.	91.8 cm.	4.3 cm.
Chest (contracted)	80.6 "	82.4 "	1.8 "
Forearm	25. "	26.8 "	1.8 "
Upper arm (flexed)	27.5 "	29 "	1 5 "
Shoulders (width)	38 7 "	40.5 "	1.8 "
Hips	78.7 "	84.4 "	5.7 "
Thigh	48.7 "	52.6 "	3.9 "
Calf	31.2 "	33. "	1.8 "

OVEREXERTION.

However necessary for the preservation of health physical exercise may be, overexertion should be carefully avoided. Overstrain and hypertrophy of the heart are often the results of excessive exertion. Dr. Da Costa has described a form of "irritable" and weak heart occurring especially among soldiers, which he has clearly traced to overexertion. Severe labor and violent athletic exercises have been followed by like serious results. Long-distance pedestrianism has furnished within recent years quite a number of individuals who were broken down in health by the excessive strain on the physical organization involved. Cardiac strain is not infrequent among this class.

Spasm, paralysis, or atrophy of muscles sometimes results, when these are exhausted by uninterrupted or excessive exercise. This effect is shown by writers' and telegraphers' cramp, and similar affections. For these reasons it is important that both exercise for health and actual work should be so regulated as to conduce to the individual's benefit, and not to his detriment.

[1] Apparatus used: Weights, 4500 to 6750 grammes; Dumb-bells, 1125 grammes; Indian clubs, 1575 grammes; Pulleys.

[On the subjects embraced in this chapter the following works may be studied with advantage:—

A Braynton Ball, Physical Exercise, in Buck's Hygiene and Public Health, vol. i.—Wm. Blaikie, How to Get Strong and How to Stay So.—A. Maclaren, Training in Theory and Practice.]

CHAPTER XIV.

Baths and Bathing.

The most important sanitary object of bathing is cleanliness. A secondary object of the bath is to stimulate the functions of the skin, and to produce a general feeling of exhilaration of the body. Baths are used of various temperatures. A cold bath has a temperature of from 4° to 24° C. (40° to 75° F.); a tepid bath from 24° to 30° C. (75° to 85° F.), a warm bath from 30° to 38° C. (85° to 100° F.), and a hot bath from 38° to 43° C. (100° to 110° F.).

Tepid, warm, or hot baths are used principally as cleansing agents or as therapeutic measures. They cause dilatation of the cutaneous capillaries, diminish blood-pressure, and reduce nervous excitability. The hot bath is also a method for restoring warmth to the body in certain cases of shock, or to remove the immediate effects of injurious exposure to low temperature.

The so-called Russian and Turkish baths, so popular in the larger cities of this country, are modifications of vapor- and hot-air baths, or rather combinations of these with cold baths. The Turkish bath is especially to be recommended for its depurative and invigorating effects.

Cold baths are used not merely for their cleansing effects, but principally for their stimulating effects upon the system. When first plunging into a cold bath there is usually a momentary shock; the respiration is gasping, and the pulse is increased in frequency. These symptoms disappear in a few moments, however, and reaction follows. To a healthy person a cold bath is a delightful general stimulant, removing the sense of fatigue after physical exertion and causing an extremely refreshing sensation throughout the body.

As a therapeutic measure, the cold bath has a wide field of usefulness. For the reduction of the bodily temperature in fevers and inflammatory diseases, and especially in heat-stroke, it is more prompt and effective than any other agent at the command of the physician.

Sea-Bathing.—The most stimulating form of the cold bath is doubtless the salt-water bath as taken at the sea-shore. The revulsive effect of the impact of the waves and breakers upon the skin and the stimulation due to the saline constituents of the sea-water heighten the invigorating effects of the simple cold bath. The beneficial results of sea-bathing are, however, not entirely due to the bath, but are to a great degree dependent upon the bracing air of the sea-shore, absence of the care and anxieties of business, and the temporary change in food and habits that a residence at the sea-side involves. Nevertheless, salt-water baths are more stimulant to the skin than those of simple water, and part of the good effects of sea-bathing can often be obtained from a salt-water bath taken at home. The following mixture of salts dissolved in about 125 litres of water for one bath makes a fairly good substitute for a sea-bath:—

Take of Chloride of sodium (common salt), . . .	4 kilogrammes.
Sulphate of sodium (Glauber's salt), . . .	2 "
Chloride of calcium, ...	½ kilogramme.
Chloride of magnesium, ...	1½ kilogrammes.

There is a prevalent popular belief that it is extremely dangerous to enter a cold bath when heated or perspiring. The author is of the opinion that this belief is erroneous. The stimulant and bracing effects of the cold bath are most manifest if it be taken while the individual is very warm or bathed in perspiration. Several years ago the author made a series of observations upon himself to determine the effects of the cold bath when the body was very warm. Every afternoon a free perspiration was provoked by a brisk walk of about 2 kilometres in the sun. As soon as the clothing could be cast off, and while the body was still freely perspiring, a plunge was taken into a fresh-water bath of about 15.5° C. (60° F.). No ill results followed; on

the contrary, the sensation immediately following the bath, and for six or eight hours afterward, was exceedingly pleasant. The health remained perfect, and the weight decidedly increased during the two months the practice was continued. There is probably no danger to a healthy person in this practice, but it is considered advisable to immerse the head first ("take a header"), to avoid increasing the blood-pressure in the brain too greatly, which might result if the body were gradually immersed from the feet upward.

RULES FOR BATHING.

The following series of rules have been issued by the English Royal Humane Society, and are all worth observing by bathers: "Avoid bathing within two hours after a meal. Avoid bathing when exhausted by fatigue or from any other cause. Avoid bathing when the body is cooling after perspiration. Avoid bathing altogether in the open air, if, after having been a short time in the water, there is a sense of chilliness, with numbness of the hands and feet; but bathe when the body is warm, provided no time is lost in getting into the water. Avoid chilling the body by sitting or standing undressed on the banks or in boats, after having been in the water. Avoid remaining too long in the water, but leave the water immediately if there is the slightest feeling of chilliness. The vigorous and strong may bathe early in the morning on an empty stomach. The young, and those who are weak, had better bathe two or three hours after a meal; the best time for such is from two to three hours after breakfast. Those who are subject to giddiness or faintness, or suffer from palpitation or other sense of discomfort at the heart, should not bathe without first consulting their medical adviser."

To these instructions may properly be added that a warm or hot bath should be avoided, if the person is liable to exposure to cold within a few hours after the bath; that women should, as a rule, not take a cold bath while menstruating, or during the last two months of pregnancy; and that persons

suffering from organic heart disease should especially avoid surf-bathing.

After bathing the body should be thoroughly dried with soft towels, otherwise eczematous eruptions are liable to follow in the parts subject to friction from opposing surfaces of the skin, as in the groins, the perinæum and inner surface of the thighs, the armpits, or the under surface of the breasts in women in whom these organs are large and pendant.

Friction of the skin with a coarse towel, or so-called "flesh-brush," is a popular practice, but is not to be universally commended. The hyperæmia of the surface thus produced may sometimes induce cutaneous diseases (erythema, eczema, psoriasis) in those predisposed.

DANGERS OF COLD BATHING.

One of the most serious dangers of cold bathing, but which is not sufficiently appreciated, is the tendency to nausea and vomiting if the stomach contains much food. There can be no doubt that many of the cases that are called "cramp," and which frequently result in drowning, are due to this cause.[1]

Cramps of the various muscles sometimes occur, rendering the bather helpless, and if in deep water he is liable to drown before assistance can reach him.

HOW TO RESTORE THE APPARENTLY DROWNED.

In drowning death takes place by asphyxia. The respiration is arrested by the submersion of the head, the carbonized blood gradually poisons the system, and the heart ceases to beat. So long as the heart will react to its appropriate stimulus the person may be restored to life. The first thing to do, therefore, after a recently-drowned person is taken out of the water, is to attempt to re-establish the arrested respiration. Several methods are in use for this purpose. Sylvester's is one of the simplest. It is as follows:—

[1] So far as the author is aware, Dr. John Morris, of Baltimore, first called especial attention to this source of danger.

The body being placed on the back (either on a flat surface or, better, on a plane inclined a little from the feet upward), a firm cushion or similar support (a coat rolled up will answer) should be placed under the shoulders, the head being kept in a line with the trunk. The tongue should be drawn forward to raise the epiglottis and uncover the windpipe. The arms should be grasped just above the elbows and drawn upward until they nearly meet above the head, and then at once lowered and replaced at the side. This should be immediately followed by pressure with both hands upon the belly, just below the breast-bone. The process is to be repeated fifteen to eighteen times a minute.

Several years since the Michigan State Board of Health published a method which is comprehensive, effective, easily understood, and readily carried out. This method has also been adopted by the United States Life-Saving Service. The following are the details of the Michigan method:—

Rule 1.—Remove all the obstructions to breathing. *Instantly* loosen or cut apart all neck- and waist- bands; turn the patient on his face, with the head down hill; stand astride the hips with your face toward his head, and, locking your fingers together under his belly, raise the body as high as you can without lifting the forehead off the ground, and give the body a smart jerk to remove mucus from the throat and water from the windpipe, hold the body suspended long enough to slowly count *one—two—three—four—five*, repeating the jerk more gently two or three times.

Rule 2.—Place the patient on the ground face downward, and, maintaining all the while your position astride the body, grasp the points of the shoulders by the clothing; or, if the body is naked, thrust your fingers into the armpits, clasping your thumbs over the points of the shoulders, and *raise the chest as high as you can* without lifting the head quite off the ground, and hold it long enough to slowly count *one—two—three.* Replace him on the ground with his forehead on his flexed arm, the neck

straightened out, and the mouth and nose free; place your elbows against [the inner surface of] your knees and your hands upon the sides of his chest *over the lower ribs, and press downward and inward* with increasing force long enough to slowly count *one—two.* Then suddenly let go, grasp the shoulders as before, and raise the chest; then press upon the ribs, etc. These alternate movements should be repeated ten or fifteen times a minute for an hour, at least, unless breathing is restored sooner. Use the same regularity as in natural breathing.

Rule 3.—After breathing has commenced *restore the animal heat.* Wrap him in warm blankets, apply bottles of hot water, hot bricks, or anything to restore heat. Warm the head nearly as fast as the body lest convulsions come on. Rubbing the body with warm cloths or the hands and slapping the fleshy parts may assist to restore warmth and the breathing also.

If the patient can *surely* swallow, give hot coffee, tea, milk, or a little hot sling. Give spirits sparingly, lest they produce depression.

Place the patient in a warm bed, and give him plenty of fresh air. Keep him quiet.

Beware! *Avoid delay. A moment* may turn the scale for life or death. Dry ground, shelter, warmth, stimulants, etc., at this moment are nothing—*artificial breathing is everything*—is the *one remedy*—all others are secondary. *Do not stop to remove wet clothing.* Precious time is wasted, and the patient may be fatally chilled by exposure of the naked body, even in summer. Give all your attention and efforts to restore breathing by forcing air into, and out of, the lungs. If the breathing has just ceased, a smart slap on the face or a vigorous twist of the hair will sometimes start it again, and may be tried incidentally. Before natural breathing is fully restored, do not let the patient lie on his back unless some person holds the tongue forward. The tongue by falling back may close the windpipe and cause fatal choking.

Do not give up too soon; you are working for life. Any

time within two hours you may be on the very threshold of success without there being any sign of it.[1]

PUBLIC BATHS.

In all large cities and towns provision should be made for free public baths, conducted under official supervision, and for the especial use and benefit of the poorer classes. General cleanliness is not merely a factor in the preservation of the public health, but there is good reason to believe that the cause of good order and decency would likewise be promoted by furnishing the public the means of easily and cheaply keeping clean. Several of the larger cities in the country have established public baths upon a limited scale, and these have been very popular and have doubtless been of great benefit. The author has shown[2] that about five-sixths of the inhabitants of the large cities in the United States have no facilities for bathing except such as are afforded by a pail of water and sponge, or in summer the proximity of some body of water easily accessible.

[1] Report of Michigan State Board of Health, 1874, pp. 91-99.
[2] Address in State Medicine, Journal American Medical Association, July 2, 1887.

CHAPTER XV.

Clothing.

The primary object of clothing is the protection of the body against the injurious influences of heat, cold, and moisture. Secondarily, the moral sense of civilized communities demands that the nude human body shall not be exposed in public. Hence, there are moral as well as sanitary reasons for the wearing of clothing; only the latter can be considered in this place.

Bodies radiate or absorb heat accordingly as they are surrounded by a medium having a lower or higher temperature than themselves. In order, therefore, to avoid chilling of the human body, if exposed to a temperature below 37° C. (98° F.), clothing must be worn to prevent or retard radiation of the body-heat. Exposure of the unprotected body to a low temperature would not merely cause chilling of the surface, owing to the rapid loss of heat, but would incidentally produce congestion of internal organs by causing constriction of the superficial capillaries.

Clothing is also worn as a protection against great heat. The head, especially, needs protection from the sun's rays.

CLOTHING MATERIALS.

The materials from which clothing is made are, principally, cotton, linen, wool, silk, and the skins of animals. Of these, probably the most universally used is *cotton*. It is cheap, durable, does not shrink when wet, absorbs little water, and conducts heat readily. It is therefore especially valuable for summer garments, allowing rapid dissipation of the body-heat and evaporation of the perspiration.

Linen conducts heat even better than cotton, and is for

this reason largely used for summer clothing. Its principal advantage over cotton is that it is more durable and less harsh to the skin.

Wool absorbs water readily and is a bad conductor of heat. It is therefore valuable as a winter garment, retarding radiation from the body. Woolen undergarments should be worn at all seasons, in order to prevent too rapid changes of the surface, and so invoking diseases depending upon chilling of the body. Clothing of pure wool (flannels) is liable to irritate the skin of some persons. A mixture of wool and cotton, known as "Saxony wool," is softer and less irritating, and makes a serviceable substitute for pure wool.

Silk is often used for undergarments. It is light, soft, and a bad conductor of heat.

The skins of animals, with the fur on, are often used for outside clothing. They furnish great protection against severe cold. The skin is impermeable to wind and rain, while the thick, pilous covering of fur retards to a very great degree the radiation of heat. In British America, the Northwestern States and Territories, and in the Arctic regions, the use of skin clothing is necessary for comfort.

As a protection against moisture (rain and snow) *rubber cloth* is used for overcoats, etc. While it serves effectually in keeping out the rain, it prevents evaporation of the perspiration, increasing the liability to chill, and rendering the person wearing it very uncomfortable, except in cold weather.

Leather is used almost exclusively in the manufacture of foot-wear. It is sometimes used, however, for other articles of clothing, such as coats, trowsers, etc. It furnishes most effective protection against cold.

The *color* of the clothing is of great importance. Exposed to the sun, white wool or silk absorb very little more heat than linen or cotton, but the same material, of different colors, when exposed to the sun's rays, exhibits marked differences in absorptive capacity. The following table shows the

results of some experiments of Pettenkofer. The material used was cotton shirting of the colors named:—

White absorbed	100 heat units.
Light Sulphur Yellow absorbed	102 " "
Dark Yellow absorbed	140 " "
Light Green absorbed	155 " "
Turkey Red absorbed	165 " "
Dark Green absorbed	168 " "
Light Blue absorbed	198 " "
Black absorbed	208 " "

When protected from the sun's rays, however, the material becomes important and the color is of little consequence. Wool, being a bad conductor of heat, retards radiation from the body, and is hence the best material for winter clothing.

Gases and vapors, probably also disease-germs, are absorbed by clothing, and may be thus conveyed from place to place. It has been found that woolen clothing possesses this power of absorption to a much greater degree than linen or cotton. The bad odor of a crowded room or of tobacco-smoke frequently clings to woolen garments for days, although they may be exposed constantly to the air during the interval. It would be advisable, therefore, that physicians attending infectious diseases, hospital attendants and nurses, should wear linen or cotton clothing instead of woolen.

Clothing should be made to *fit* properly. It should not restrain muscular movements, obstruct the circulation, or compress organs. Hence, corsets, belts, and garters are to be condemned. It is a fact of common observation that moderately loose clothing is warmer than close-fitting.

Especial attention should be given to the shape and fitting of foot-wear. Boots and shoes are usually made with little regard to the physiological anatomy of the foot, and as a result the feet of most Americans are deformed, beauty and usefulness being in a great degree sacrificed to the Moloch of fashion.[1]

[1] See a practical paper by Dr. Benj. Lee, A Shoe That Will Not Pinch, in Sanitarian for June, 1884, p. 493.

Dyes used for coloring fabrics are sometimes poisonous. The author has repeatedly seen troublesome eruptions, and even ulcerations of the legs, from wearing stockings dyed with aniline compounds.

By appropriate treatment clothing can be made *non-inflammable.* Tungstate and phosphate of soda are used to reduce the inflammability of fabrics. The addition of 20 per cent. of tungstate of soda and 3 per cent. of phosphate of soda to the starch-sizing used for stiffening linen is effective. The material is not injured by it, and a smooth surface and polish can be obtained under the hot iron. Prof. Kedzie has recommended borax for the same purpose. He says: "The simplest and easiest way to make your cotton and linen fabrics safe from taking fire is to dissolve a heaped teaspoonful of powdered borax in $\frac{1}{2}$ pint of starch solution. It does not injure the fabric, imparts no disagreeable odor, and interferes in no way with the subsequent washing of the goods. It does not prevent the formation of a smooth and polished surface in the process of ironing. Borax can be found in every village, and is within the reach of all. It is a cheap salt, and its use for this purpose is very simple."[1]

[The following works may also be studied to advantage:—

Hammond, Hygiene, p. 579.—L. Meyer, Kleidung, in Realencyclopædie d. ges. Heilk., Bd. VII, p. 446.—Van Harlingen, Care of the Person, in Buck's Hygiene and Public Health, vol. i.]

[1] Michigan State Board of Health, p. 181. 1880.

CHAPTER XVI.

Disposal of the Dead.

When life is extinct in the animal body decomposition begins. This may be either putrefactive or non-putrefactive. The difference between the two processes has been explained by Liebig. In putrefaction of organic matters only the elements of water take part in the formation of the new compounds which result, while in non-putrefactive decomposition or decay the oxygen of the air plays an important part. Putrefaction can go on under water, while decay can only take place when the supply of free oxygen is abundant.

The prompt removal of the bodies of the dead from the immediate vicinity of the living is a matter of prime sanitary importance. If death results from a contagious or an infectious disease, the necessity for the removal of the corpse is evident. But, even where there is no danger of propagation of infectious disease, the products of putrefaction and decay may give rise to serious derangements of health if allowed to pollute the air.

The chief methods of disposal of the dead are burial in the earth, entombment in vaults, and cremation.

INTERMENT.

The most common method of sepulture is burial in the earth. The corpse is usually inclosed in a case (coffin) of wood or metal, and buried from 1 to 2 metres deep. Here decomposition sets in, which is at first putrefactive and later on non-putrefactive. In the course of several years, from five to ten, the entire body, with the exception of the bones, has usually disappeared and become converted into a dry mold.

The soil of a burial-ground should be dry and porous, so

as to be easily permeated by the air. In a sandy or gravelly soil the decay of a corpse is much more rapid than in a moist, clayey soil. In the latter the bodies more readily undergo putrefaction, or become converted into a substance termed adipocere. It has been calculated that in a gravelly soil the decay of a corpse advances as much in one year as it would in sand in one and two-thirds, and in clay in two to two and one-third years. The decay of the dead bodies is principally (if not entirely) dependent upon the presence of living vegetable organisms. If the access of free oxygen is prevented, the bacteria of putrefaction will thrive and cause putridity. If, however, the soil is loose, porous, and easily permeable by the air, the bacteria of decay will be present and produce their characteristic effects.

The barometric pressure seems to affect the decomposition of dead bodies. For example, at the refuge of St. Bernard, in the high Alps, the bodies of those dying are not buried, but exposed to the air, where they undergo a drying, shrinking, and mummification instead of putrefaction or decay.

Alternate saturation and drying of the soil promotes the rapidity of decay.

Certain occupations are said to produce changes in the tissues which resist decay. Thus, tanners are supposed to resist the final changes of the tissues longer than persons of other occupations. Shakespeare makes the grave-digger in Hamlet say: "A tanner will last you nine years." The corpses of those poisoned by phosphorus, arsenic, sulphuric acid, or corrosive sublimate also decay more slowly than those of cases of infectious diseases.

All the tissues may be converted into adipocere, but in the large majority of cases only the fat and connective tissue undergo this change.

SUPPOSED DANGERS OF BURIAL-GROUNDS.

Popular sanitary literature teems with supposed instances of the injurious influences of cemeteries upon the health of

persons living in their vicinity. An unprejudiced consideration of the subject shows, however, that there is no trustworthy evidence that any of the gases exhaled by decaying or putrefying bodies are injurious to health. The air of closed burial-vaults may be dangerous from the large proportion of carbon dioxide contained in it, but the other gaseous products of decomposition have no deleterious effects. The dangers to health from the proximity of cemeteries are doubtless very much exaggerated. Pettenkofer and Erismann have shown that a single large privy-vault, containing about 17 cubic metres of excrement, gives off nearly as large an amount of putrefactive gases in the course of one year as is exhaled by a burial-ground containing 556 decomposing corpses in ten years.

Where bodies are properly buried, and the ground is not overcharged by corpses, it is not probable that infectious diseases are propagated from interred bodies. There are no facts on record which show that such an event has occurred.

The dangers of pollution of water by cemeteries have also been much overestimated. The purifying power of soil-strata, through which the water is compelled to percolate before reaching the well after becoming charged with the products of decomposition, is in most cases sufficient to remove all deleterious matters.

Cemeteries should not be located within a city, but must be easily accessible. The soil should be dry gravel or sand, with a low ground-water level. The graves need not be deeper than $1\frac{1}{2}$ metres to the top of the coffin.

ENTOMBMENT IN VAULTS.

Burial-vaults in churches or in the open air should be discountenanced. The gases of decomposition are given off directly to the air without the modifying power of the soil, and often constitute a nuisance, even if not deleterious to health. Entombment in vaults or crypts has not a single favorable circumstance to recommend it.

CREMATION.

Within recent years the rapid incineration of the dead in properly-constructed furnaces has been frequently recommended. In the United States a cremation furnace was built several years ago at Washington, Pa., by the late Dr. J. C. LeMoine. Among the remains of those cremated were those of the late Dr. Samuel D. Gross, the distinguished surgeon. The practice has not gained very many adherents, however, although cremation societies have been organized and furnaces built in several of the cities throughout the country. Aside from the objections urged by the more conservative classes, who desire to adhere to the time-honored custom of interment, serious legal objections have been brought forward. In cases where poisoning is suspected some time after death, the cremation furnace would have destroyed every evidence of crime, and conviction of a criminal poisoner could not be obtained.

The real advantages of cremation, such as rapid destruction of a corpse, economy of space in keeping the remains, and avoidance of pollution of the soil by decaying bodies, and possible pollution of air and water, are more than counterbalanced by the expense and the medico-legal objection mentioned. From a sanitary point of view, cremation is not necessary in this country. A proper regulation of cemeteries will prevent any possible dangers to the living from pollution of the air, soil, or water by the decaying remains of human beings.

INTERMENT ON THE BATTLE-FIELD.

After battles, the disposal of the bodies of the slain is often a serious problem. Naegeli proposes the following method of interment: After selecting the place of burial, the sod and layer of humus are removed from a sufficiently large surface and thrown to one side. The corpses are then laid upon the denuded place, and the layers of corpses separated by sand, gravel, or fine brush-wood. A trench is then dug around the pile of dead and the soil gained is thrown over the corpses until they are

covered to a depth of 1 metre, when the humus and sod are placed over the whole. This furnishes a dry grave in which decay rapidly takes the place of putrefaction, and the corpses soon molder away. The same procedure may be followed in cases of epidemics where the number of deaths is too great to properly bury them in single graves.

CHAPTER XVII.

The Germ Theory of Disease.

The ruling doctrine in the pathology of the present day is the germ theory of disease. Based upon the doctrine of *omne vivum ex vivo*, and supported by strong experimental and clinical evidence, it is accepted by the great majority of physicians. Its advocates claim that the large class of diseases known as contagious or infectious are all due to the presence in the blood or tissues of minute organisms, either animal or vegetable. Many other diseases, not at present included in the above class by general pathologists, are also believed, by the adherents of the germ theory, to be caused in the same way. The following constitutes a brief review of the most prominent facts in the history of the doctrine:—

The doctrine of the vital nature of the contagium of disease—the *contagium animatum* of the older writers—was held in a vague way by many of the physicians of the past, but it was not until the latter part of the last century that the theory took definite shape. In the works of Hufeland, Kircher, and Linné the idea is expressed with more or less directness that the propagation of infectious diseases depends upon the implantation of minute independent organisms into or upon the affected individual. This hypothesis was, however, first clearly enunciated and defended with great force by Henle in 1840. Three years earlier, Cagniard de la Tour and Schwann had established a rational basis for the theory by their observations upon the yeast-plant and its relation to fermentation. In 1835 Bassi had discovered in the bodies of silk-worms affected by *muscardine*, a disease of these insects which proved very destructive, a parasite which was soon shown to be the cause of the disease. Within the next few years, Tulasné, DeBary, and Kuehn

proved that certain fungi were the causes of the potato-rot and other diseases of plants. Schoenlein, Malmsten, and Gruby, between 1840 and 1845, demonstrated that those skin diseases of man classed as *the tineæ* were due entirely to the action of vegetable parasitic organisms.

Up to this time the germ theory, as now accepted, had received no support from experiments. All the diseases claimed as parasitic were purely local; so far as the parasitic nature of the general diseases was concerned, all was hypothetical. In 1849, Guérin Méneville discovered a corpuscular organism in the blood of silk-worms affected by the *pébrine*, which was later proven by Pasteur to be the true cause of this destructive disease. Pollender, in 1855, and Brauell, in 1857, found numerous minute rod-like organisms (bacteria) in the blood of animals dead from splenic fever. In 1863 Davaine investigated the subject more fully, and showed beyond doubt that the little organisms discovered by Pollender were the true cause of splenic fever, or anthrax. The more recent researches of Robert Koch upon the history of these bacteria or bacilli of splenic fever have removed all doubt of their etiological significance.

In 1883 the last-named observer startled the medical world by the assertion that consumption or tuberculosis was a disease of microbic origin, and dependent upon the presence, in the affected tissues, of an organism which he named *bacillus tuberculosis.* Much controversy arose upon this point, but Koch fortified his position so strongly with proofs, both experimental and clinical, that it may now be regarded as fully demonstrated. Koch has likewise shown (1885) that Asiatic cholera is due to a bacterial organism, termed by him the "comma bacillus," from its shape. It is generally regarded by bacteriologists, however, to belong to the class of organisms known as spirilla, and not to the bacilli. Eberth discovered the bacillus which is now generally accepted as the cause of typhoid in 1880; Fehleisen, the micrococcus of erysipelas in 1883; Obermeier, the spirillum of relapsing fever in 1868; Schutz and Löffler discovered the

bacillus of glanders in 1882; Neisser announced the discovery of the micrococcus of gonorrhœa in 1879. The bacillus of leprosy was discovered by Hansen in 1879. The micro-organisms of malaria (oscillaria malariæ), which are believed to be animal organisms, were discovered by Laveran in 1881. This organism is different from the *bacillus malariæ* of Klebs and Tommasi-Crudeli, which most pathologists do not regard as possessing any pathological significance. Pneumonia may also be regarded as a microbic disease, since the demonstrations of Sternberg, Weichselbaum, and Fränkel of the constant presence of the micrococcus Pasteurii in the sputa in that disease.

The careful observations and researches of the investigators mentioned, as well as of many others who have worked earnestly in this field, have established the germ theory of disease upon a secure foundation. For the diseases mentioned the parasitic origin may be accepted as fully proven. For a number of others, among which may be mentioned small-pox, yellow fever, diphtheria, scarlet fever, typhus fever, measles, hydrophobia, etc., the etiological connection between the disease and certain hypothetical organisms not yet discovered appears probable.

In connection with the germ theory there has arisen of late a very important question in its bearing upon preventive medicine. This is the value of the so-called protective inoculations against infectious diseases. The protective influence of vaccination against small-pox is firmly established by indubitable evidence. Within the last three or four years a procedure introduced by Pasteur to protect animals against certain fatal infectious diseases, such as splenic fever, fowl-cholera, and rabies, has claimed much attention. Pasteur's observations were first made upon the disease termed chicken-cholera. He found that the blood of the dead fowls, or of those attacked by the disease, swarmed with bacteria. Inoculation of healthy fowls with this diseased blood, or with the bacteria alone, carefully freed from all animal fluids, produced the same disease. The bacteria were therefore assumed to be the cause of the disease. The

investigator then took a quantity of these bacteria and "cultivated" them through a number of generations, using sterilized chicken-broth as a culture medium. Fowls inoculated with the result of the last cultivation were still attacked by the same symptoms, but in a very mild degree, and almost uniformly recovered from the disease. On subsequent inoculation with infected blood no effect was produced upon the "vaccinated" fowls, while the same blood introduced into fowls not "protected" by the previous inoculation produced its customary fatal effect. Pasteur and others repeated these experiments with the organisms found in the blood in splenic fever and obtained similar results. Inoculations made with cultivations from the spinal cord of animals suffering from rabies have also been claimed as protective against this disease and hydrophobia. These protective inoculations have been made upon large numbers of sheep and cattle within the past three years, and with very remarkable success. Recently, however, it has been shown that the protection afforded by the inoculation is a very temporary one, and that after a variable but brief interval the protected animals are again liable to be fatally attacked by the disease. The opinion seems to be justified that cultivation produces only a temporary degeneration of the bacteria, which rapidly disappears when the organisms are again brought in relation with their proper nutritive fluid. The "protective inoculations" produce a mild attack of the disease, which is for a time a bar against a second attack; but the effect soon wears off, leaving the animal in its pristine condition of receptivity toward the infective material.

[The following works on this subject are recommended to the student:—

Sternberg and Magnin, The Bacteria; second edition.—Fluegge, Fermente und Mikroparasiten, in von Pettenkoffer und Ziemssen's Handbuch d. Hygiene.]

CHAPTER XVIII.

Contagion and Infection.

The adjectives "contagious" and "infectious" are used to designate certain diseases which are propagated by immediate contact, or through the intervention of some other medium, from the sick to the healthy. The matters in which reside the morbific power are now believed by many to be vegetable organisms, but not a few pathologists hold to the view that the real contagia, or disease-bearing agents, are modified animal cells or abnormal fluids.

The differentiation between contagion and infection is not easy. Many of the diseases commonly called contagious are also infectious; that is, they are propagated not merely by direct contact, but also by air, water, or food which may have become infected with the morbific agents. Syphilis, for example, may be regarded as simply a contagious disease; at the present day, at least, we cannot conceive syphilis to be propagated by breathing infected air or drinking water contaminated with the poison of syphilis. Cholera, typhoid, and yellow fevers, on the other hand, are examples of infectious diseases, neither of them being directly contagious, but conveyed from sick to well through the medium of contaminated air, water, or food. Between these two stand small-pox and typhus fever (and perhaps the other exanthemata), which are not merely contagious, but infectious also.

There is still a third class of acute diseases not properly included in either of the classes mentioned. This is the class of miasmatic diseases, of which malarial fevers are the type. According to recent observations, pneumonia ought, perhaps, to come in this class.

The contagious and infectious diseases are of particular

interest to sanitarians, because it is believed that by judicious carrying out of sanitary measures they can be prevented. Hence they are sometimes termed preventable diseases. Another peculiarity of the infectious diseases is that they usually occur in groups of cases. Thus, small-pox, measles, scarlet fever, typhus fever, diphtheria, and others of the class do not occur sporadically, as it is termed; that is to say, it rarely happens that only one case of small-pox is observed in a locality, unless active measures are at once taken to stamp it out. Usually a number of cases occur successively, and in most instances the succeeding cases can be traced ultimately to the first case.

Contagious and infectious diseases frequently appear as epidemics. Authorities differ as to the proper definition of an epidemic; that is, given the population of a place, how many cases of an infectious or contagious disease are necessary before the disease can be considered epidemic at such place. The following formula was given by the New Orleans Medical and Surgical Association in response to the query, "Under what circumstances is it proper to declare such diseases (diphtheria, scarlet fever, measles, small-pox, yellow fever, etc.) epidemic in a place?" The answer given is that the disease should be declared epidemic when the number of cases should reach these proportions[1]:—

For a population of			100	.	.	5	per cent.	
"	"	"	500	.	.	4	"	"
"	"	"	2,000	to	5,000	22½	"	thousand.
"	"	"	6,000	to	10,000	16	"	"
"	"	"	20,000	to	50,000	8	"	ten thousand.
"	"	"	50,000	to	100,000	4	"	" "
"	"	"	200,000	.	.	1	"	" "

A disease is said to be *pandemic* when it spreads rapidly over a great extent of country, and *endemic* when it is constantly present in a place. Diseases which may be prevalent in certain localities, *i.e.*, endemic, not infrequently spread over larger areas

[1] Public Health, vol. vi, pp. 416, 417.

of country,—overflow their borders, as it were,—and become epidemic or pandemic. Thus cholera, which is endemic in certain districts of India, frequently spreads over adjacent territory, and at times the epidemic wave, as it has been called, rolls over nearly the whole world. Plague, malarial and yellow fevers make similar epidemic excursions into other countries, or sections of country, at a distance from the places where they are endemic.

Contagious and infectious diseases possess another peculiarity in that a certain time is required after the introduction of the poison into the system before the disease manifests itself by its typical symptoms. This is called the "stage of incubation," and varies for different diseases. The following table shows the stage of incubation of a number of such diseases:—

TABLE XXVI.

INCUBATION OF INFECTIOUS DISEASES.

Measles,	10 days.
Small-pox,	12 "
Mumps,	18 "
Diphtheria,	3 "
Scarlet fever,	3 "
Whooping-cough,	14 "
Typhoid fever,	14 "
Typhus fever,	1 to 2 "
Chicken-pox,	4 "
Erysipelas,	4 "

The period during which the infectiveness of the patient lasts also varies. In some cases it probably depends upon the measures taken to prevent the spread of the disease, *e.g.*, disinfection of the patient and his surroundings.

CHAPTER XIX.

History of Epidemic Diseases.

An important part of the knowledge of the sanitarian is that which relates to the history of the great epidemic diseases which have at various periods devastated large areas of the inhabited world. In this chapter the history of these diseases will be briefly traced. Although some of these diseases have nearly or quite ceased, a knowledge of their habits and of the causes that finally led to their extinction is of great value, for the reason that the principles and measures of prevention which were effective in times past are the same which must apply at present and in the future. Hence, time spent in looking back over the fields traversed and noting victories won will not be wasted.

The epidemic diseases which will here claim attention are the Oriental plague, the sweating sickness, small-pox, Asiatic cholera; typhus, typhoid, scarlet, relapsing, and yellow fevers; diphtheria, dengue, epidemic influenza, and syphilis. In addition, some information will be given on certain of the diseases of animals transmissible to man. Among these are sheep-pock, actinomycosis, bovine tuberculosis (perlsucht), rabies, anthrax (milzbrand), and glanders.

THE ORIENTAL PLAGUE.

The Oriental plague, bubonic plague, the black death, or simply the "plague," or great pestilence, overtopping in its fatality all other pestilences, is mentioned by a number of the Greek and Latin medical authors. The first account which clearly refers only to this disease is given by Procopius. According to this and other contemporary authors, the disease began to spread in the year 542 from Lower Egypt, passing in one direction along the coast of Northern Africa, and in the other

invading Europe by way of Syria and Palestine. In the course of the succeeding years this pandemic reached "the limits of the inhabited earth," in the language of the writers of the day. The disease prevailed about half a century, and produced the greatest devastation wherever it appeared. "Cities were devastated, the country converted into a desert, and the wild beasts found an asylum in the abandoned haunts of man."[1]

The plague is an acute infectious disease, which is characterized by an affection of the lymphatic system, *i.e.*, inflammation and swelling of the external and internal lymphatic glands. Accessory symptoms are petechial spots upon the skin, and hæmorrhages from various organs, as the stomach, nose, kidneys, rectum, and uterus. Those attacked suffer in varied degrees of intensity. In some, a fulminant form occurs which carries off the patient within three days; there is another class of cases in which buboes develop, with accompanying fever and hæmorrhages; and, finally, a light form, rarely fatal, in which only the local symptoms are manifested. In the great pandemic of the plague in the fourteenth century cough and bloody expectorations were very frequent. In the later epidemics hæmorrhage from the lungs has been rarely noticed as a symptom.

About the middle of the fourteenth century the bubonic plague made a second incursion into Europe from its home in the East. A most graphic description of its ravages is given by Boccaccio in the "Decameron." This author states that in 1359, "between March and July following, according to authentic reckonings, upward of 100,000 souls perished in the city (Florence); whereas, before that calamity it was not supposed to contain so many inhabitants."

This terrible epidemic was forcibly characterized by its common name, "the black death." Hecker estimates that during its continuance, from 1347 to 1351, 25,000,000—one-fourth of the probable total population of Europe—died. In various cities the mortality was—in London, 100,000; in Paris, 50,000; in

[1] Warnefried, quoted by Hirsch, Hist-Geographische Pathologie, I, p. 350.

Venice, 100,000; in Avignon, 60,000; in Marseilles, 16,000, in one month. It was said that in all England scarcely a tenth part of the population escaped death from the disease.

The moral effects of this great pandemic of the plague were hardly less deplorable than the physical. Religious fanaticism held full sway throughout Europe, finding its vent in all manner of excesses. The so-called Brotherhood of the Cross, otherwise known as the Order of Flagellants, which had arisen in the thirteenth century, but had been suppressed by the ecclesiastical authorities, was revived during the black pestilence, and large numbers of these religious enthusiasts roamed through the various countries on their great pilgrimages. Their power increased to such a degree that Church and State were forced to combine for their suppression. One consequence of this fanatical frenzy was the persecution of the Jews. These were accused of being the cause of every evil that befell mankind, and many were put to death.

In the fifteenth and sixteenth centuries the plague was generally diffused throughout Europe, and in the second third of the seventeenth century its final incursion into the Occident took place. The great epidemic in London, so graphically described by Defoe,[1] occurred in 1665. In the early part of the eighteenth century (1720) the plague visited Marseilles and Toulon; from 1769 to 1772 it was epidemic in Moldavia, Wallachia, Poland, and Southern Russia; near the close of the last, and again in the beginning of the present century, in Transylvania, Wallachia, Southern Russia, and Greece. Very recently, in 1878 and 1879, and again in 1885, the plague threatened a new irruption into European territory, being epidemic in the district of Astrachan, on the Caspian Sea.

Although the bubonic plague has never been observed in America, and has spared Europe almost entirely during the present century, it still persists in certain countries of Asia and Africa, especially in Arabia, Mesopotamia, Persia, and the coast of Tripoli.

[1] Journal of the Plague in London.

The older authors ascribed the origin of the plague to various real or supposed conditions. Comets, conjunctions of the planets, "God's just punishment for our sins," and similar causes were advanced to account for the outbreaks. Most of the writers of the post-mediæval and modern epochs ascribed the disease to meteorological conditions. Observing the fact that the plague never advanced into the torrid zone, and that an epidemic generally ended with the advent of hot weather, a high temperature was believed to be incompatible with the existence of an epidemic, and a cold or temperate climate was considered necessary to an outbreak of the disease. The exceptions to the rule are so numerous, however, that the theory of the climatic or meteorological origin of the plague failed of support. The theory which ascribed the origin of the epidemics to the influence of certain hot and dry winds or a high humidity is also insufficient. Certain geological formations have been supposed to furnish favorable conditions for the development of the disease. Facts show, however, that the disease has prevailed epidemically and endemically in various parts of the earth, and of the most diverse geological character. A certain elevation above sea-level has been held to confer immunity, but recent observations in India show that this belief is unfounded, even places at an elevation of 10,000 feet above sea-level giving no security against attack.

There is, however, one point upon which nearly all writers who mention the fact at all agree. This is that *bad hygienic conditions* are always present where plague prevails. Nearly all observers who have left their impressions on record mention the accumulation of filth in the houses and streets, deficient removal of excrementitious and other sewage matters, crowding and imperfect ventilation of dwellings as causes favoring the development and spread of the pestilence. All point out the necessity of the removal of these evils as the most important prophylactic measure to be adopted, and all of them call attention to the fact that those classes of the population most exposed to these unfavorable influences suffer most from the violence of the epidemic.

The later reports of the epidemics in Persia, India, Mesopotamia, and Russia agree in asserting that nothing seems to have promoted the epidemic and endemic prevalence of the plague so much as the material wretchedness of the inhabitants of those countries. In a collection of papers on the plague, printed by a British Parliamentary Commission in 1879, occur these statements: "The filth is everywhere," says Mr. Rennie, one of the reporters,—"in their villages, their houses, and their persons. Their dwellings are generally low and ill-ventilated, except through their bad construction; and the advantage of the natives in other parts of India, of living in the open air, is lost to the villagers of Ghurwal, from the necessity of their crowding together for mutual warmth and shelter against the inclemency of the weather." Dr. Dickson, reporting on the plague in Irak Arabi in 1876, says: "The most palpable and evident of all the causes which predispose an individual to an attack of plague during an epidemic outbreak is *poverty*. No other malady shows the influence of this factor in so striking a degree; so much so, indeed, that Dr. Cabiadis styles the plague *miseriæ morbis*. In his experience (1876–77, in Bagdad) he found that the poor were seldom spared, the wealthy hardly ever attacked."[1]

The manner of the transmission of the plague is generally by prolonged inhalation of an infected atmosphere. Hence, it may be termed an infectious disease, although it is not improbable that it may be communicated by direct contact both of persons and of fomites. It is probably due to a micro-organism, although no demonstration of the latter has been furnished up to the present time.

These considerations indicate the measures of prevention to be adopted. They consist of a rigid quarantine of persons and fomites, prompt and complete isolation of infected individuals and localities, and destruction (by fire) or thorough disinfection by steam or sulphurous-acid gas of all materials capable of conveying the virus of the disease.

[1] Hirsch, *op. cit.*, p. 370.

THE SWEATING SICKNESS.

This name concisely characterizes an epidemic disease which for the first time appeared in the city of London and other parts of England in the autumn of 1485. According to Lord Bacon,[1] the disease began about the 21st of September and lasted until near the end of October. It broke out a second time in the summer of 1507; a third time in July, 1518, spreading in the course of six months throughout England. In May, 1529, the disease made its appearance again in the latter country, spreading thence over a great part of the continent of Europe. Another very malignant epidemic broke out in the spring of 1541, lasting through the summer, and limited in its ravages to England.

With this last outbreak, in 1551, this disease disappeared entirely in England and has not re-appeared there up to the present day. In the beginning of the eighteenth century, however, a disease very similar in its symptoms and course broke out in Picardy and other districts of Northern France, being confined for a number of years to this section of the country. Toward the end of the century it spread to the south of France, and since that time has appeared epidemically at intervals, 195 distinct outbreaks having been observed in the course of 168 years, from 1718 to 1887. The disease has frequently appeared in Italy since 1755, and in various parts of Germany since 1801. In Belgium it has been observed at a few places within the present century.

The disease appeared suddenly, often at night-time. The patient was attacked with palpitation of the heart, dyspnœa, great anxiety and oppression, and profuse perspiration. A miliary eruption often appeared on the skin. In favorable cases these symptoms diminished in the course of one or two days, the urinary secretion, which had been suppressed, was restored, and the perspiration became gradually less free. Recovery ensued in from one to two weeks. In grave cases there were, in the

[1] History of Henry VII.

beginning of the attack, violent headache, delirium, convulsions, followed by a comatose condition, from which the patients rarely recovered.

This disease is undoubtedly of a miasmatic, infectious nature, as proved by its rapid spread and limitation to certain localities. It appears most frequently in the spring and summer, and is nearly always observed in marshy or damp localities. Its spread is favored by a high temperature and humidity. There is no apparent connection between the outbreaks of the sweating sickness and overcrowding or other insanitary conditions; in fact, it is stated by numerous observers, both old and recent, that children, the aged, and generally the poorer classes were remarkably exempt from the disease. The recent epidemic in France, in 1887, was investigated by Dr. Brouardel, Chantemesse, and other epidemiologists, but no trustworthy conclusions as to the nature of the disease have yet been reached.

Since the first appearance of Asiatic cholera in France, in 1832, an apparently intimate connection has been observed between the occurrence of that disease and outbreaks of sweating sickness. A disease strongly resembling the sweating sickness has also been observed in India in districts contiguous to places where cholera was at the time epidemic.[1]

SMALL-POX.

The earliest details concerning small-pox are derived from certain Chinese records, according to which it appears that this disease was known in China upward of 2000 years ago. It was also known at a very early period in India. It is believed to have been introduced into Europe in the second century by a Roman army returning from Asia. It is believed that the Emperor Marcus Aurelius died of small-pox, which prevailed in his army at the time of his death.

The first distinct references to small-pox in medical literature occur in the writings of Galen, in the second century. Rhazes,

[1] Murray, Madras Quart. Med. Journ., 1840–41. Quoted in Hirsch, *loc. cit.*, p. 83.

in the ninth century, wrote upon the disease, describing it very accurately.

The almost universal susceptibility to small-pox caused wide-spread devastation wherever it appeared previous to the introduction of vaccination. The statement is made that in England, in the last century, about one person in every three was badly pock-marked. The mortality from the disease was exceedingly great, being, in the latter half of the eighteenth century, about 3000 per million of inhabitants annually.

In India the mortality from small-pox has been exceedingly great within the last twenty years. From 1866 to 1869, 140,000 persons died in the Presidencies of Bombay and Calcutta, having a population of about 40,000,000. Several years later, from 1873 to 1876, 700,000 died from this disease.

China, Japan, Cochin China, the islands of the China Sea, and Corea are frequently ravaged by small-pox. In the latter country nearly all the inhabitants are said to bear evidence of an attack of the disease.

The Samoyedes, Ostiaks, and other natives of Eastern Siberia have frequently suffered from devastating epidemics. In Kamtchatka the disease was introduced in 1767, and produced frightful ravages. Many villages were completely depopulated.

In Mexico small-pox was introduced by the Spaniards in 1520. In a short time it carried off over 3,500,000 of the natives. In the Marquesas Islands one-fourth of the inhabitants have fallen victims to the disease since 1863.

It was first introduced into the Sandwich Islands in 1853, and carried off 8 per cent. of the natives.

Australia, Tasmania, New Zealand, and the Fejee Archipelago remain exempt to the present day from small-pox. It has several times been carried to Australia by vessels, but has always been promptly checked by the vigilance of the authorities.

On the Western Hemisphere small-pox was unknown before the arrival of the European conquerors. It has been spread by the whites or imported African slaves to nearly all the Indian

tribes of both continents. When it attacks large communities unprotected by previous outbreaks of the disease, or by inoculation or vaccination, its ravages are frightful. The mortality of unmodified small-pox is usually between 30 and 40 per cent.

Small-pox is a highly contagious and infectious disease. It is produced by actual contact, by inoculation, and by inhaling an atmosphere charged with the poison. In order to cause an outbreak two factors are necessary: first, a number of individuals susceptible to this disease, and, second, the introduction into the body, in some manner, of the virus upon which it depends.

Small-pox is spread from (1) persons sick with the disease; (2) others, not themselves sick or susceptible, but coming in contact with the poison; (3) fomites (cotton, wool, etc.), and (4) the bodies of persons dead with small-pox. It is also probable that the air in the immediate vicinity of a person sick with small-pox becomes charged with the poison and able to convey the disease. It is at present impossible to fix the distance to which this infectiousness of the air extends, but it does not ordinarily reach beyond the room in which the patient is confined.

It is a fact of common observation that the darker races are more commonly attacked, and the disease is likewise more fatal among them. The mortality among negroes is much larger than among other races.

It is a current belief that small-pox is only contagious after the development of the pustules. This is a serious error. It is probably contagious in all stages of the disease; certainly as early as the first appearance of the eruption, and probably even in the stage of preliminary fever.

One attack of small-pox usually confers immunity from the disease for life. This rule has its exceptions, however, which, if not numerous, are yet not infrequent. The author has seen a case in which the patient suffered from a third attack of the disease.

The popular belief, that persons suffering from any acute or chronic disease are less liable to be attacked by small-pox

than those at the time in good health, is erroneous. On the contrary, the subjects of chronic disease, such as consumption or dyspepsia, are much more liable to succumb to an attack of small-pox than persons previously in good health.

It is true, however, that individuals suffering from some other acute infectious disease, like scarlet fever, measles, typhoid fever, etc., are generally, though not absolutely, exempt from an attack of small-pox during the time they are sick with such disease. But if they are exposed, after recovery, to the small-pox infection, their liability to an attack is as great as in those who have not passed through a similar disease. A number of cases have been reported by Curschmann,[1] in which infection by small-pox took place on the day in which convalescence from typhoid fever was established.

The author has reported a case[2] in which the patient passed through an attack of erysipelas during the incubative stage of small-pox. From all the evidence attainable, the incubative stage was not prolonged by the intercurrent erysipelas.

Epidemics of small-pox usually begin in the autumn or winter, and lessen in violence as warmer weather approaches. The spread of the disease is slow at first, increasing in rapidity as the foci of infection multiply.

When the poison is imported into a community late in the spring or during the summer, the increase in the number of cases is exceedingly gradual until colder weather sets in. If it is introduced during the winter, the disease spreads much more rapidly, but decreases, and sometimes almost disappears, during the summer. On the return of cold weather, however, the epidemic starts out with a new lease of activity and presents great difficulties to its restriction.

A number of observers, among whom are Coze and Feltz, Lugenbühl, Weigert, Strauss, Garré, and Wolff, claim to have discovered specific organisms in the contents of variolous pustules, in the blood of patients with the disease, and in vaccine lymph.

[1] Ziemssen's Cyclopædia, vol. ii.

[2] Medical News, July 7, 1883.

Expert bacteriologists are, however, not willing to accept the evidence hitherto furnished as conclusive.

Inoculation.—The prevention or restriction of such a universal and fatal pestilence as small-pox is a matter of the deepest importance. The first attempt to limit its fatality dates from the end of the seventeenth century. It became generally known in Europe, about the year 1700, that the intentional inoculation of variolous matter into healthy individuals induced an attack of the disease, which generally ran through its various stages with less virulence than when the disease was contracted in the usual manner. In 1716 and 1717 two papers were published in the "Transactions of the Royal Society of England" giving an account of the process of inoculation. The attention of the public was especially directed to the matter, however, by the famous letter of Lady Mary Wortley Montagu, dated April 1, 1717. This letter is as follows[1]: "Apropos of distempers, I am going to tell you a thing that will make you wish yourself here. The small-pox, so fatal and so general amongst us, is here entirely harmless by the invention of *ingrafting*, which is the term they give it. There is a set of old women who make it their business to perform the operation every autumn, in the month of September, when the great heat is abated. People send to one another to know if any of their family has a mind to have the small-pox; they make parties for this purpose, and when they are met—commonly fifteen or sixteen together—the old woman comes with a nut-shell full of the matter of the best sort of small-pox, and asks what veins you please to have opened. She immediately rips open that you offer to her with a large needle—which gives you no more pain than a common scratch—and puts into the vein as much matter as can lie upon the head of her needle, and after that binds up the little wound with a hollow bit of shell; and in this manner opens four or five veins. The Grecians have commonly the superstition of opening one in the middle of the forehead, one in each arm, and one on the breast, to make

[1] The letter is addressed to Mrs. S. C. (Sarah Chiswell).

the sign of the cross; but this has a very ill effect, all these wounds leaving little scars, and is not done by those that are not superstitious, who choose to have them in the leg or that part of the arm that is concealed. The children or young patients play together all the rest of the day, and are in perfect health until the eighth. Then the fever begins to seize them, and they keep their beds two days, very seldom three. They have rarely above twenty or thirty in their faces, which never mark; and in eight days' time they are as well as before their illness. Where they are wounded there remain running sores during the distemper, which I don't doubt is a great relief to it. Every year thousands undergo this operation; and the French ambassador says pleasantly: 'They take the small-pox here by way of diversion, as they take the waters in other countries.' There is no example of any one that has died in it, and you may believe that I am well satisfied of the safety of the experiment, since I intend to try it on my dear little son.

"I am patriot enough to take pains to bring this useful invention into fashion in England; and I should not fail to write to some of our doctors very particularly about it, if I knew any of them that I thought had virtue enough to destroy such a considerable branch of their revenue for the good of mankind. But that distemper is too beneficial to them not to expose to all their resentment the hardy wight that should undertake to put an end to it. Perhaps, if I live to return, I may, however, have courage to war with them."

Soon after the date of this letter the writer's son was inoculated in Turkey, and four years later her daughter also, being the first subject inoculated in England. The practice soon became popular, but several fatal cases among prominent families brought it into disrepute, and for about twenty years very few inoculations were made in England. It was revived about the middle of the century by the founding of a small-pox and inoculation hospital in London. This continued in operation until 1822. The records of this institution showed that only

three in a thousand died of the disease thus communicated. The practice has now fallen into desuetude, being superseded by vaccination and prohibited by law in England.

Inoculation was introduced into this country in 1721 by Dr. Zabdiel Boylston, of Boston, who had his attention directed to the practice by Cotton Mather, the eminent divine.[1] During 1721 and 1722, 286 persons were inoculated by Boylston and others in Massachusetts, and 6 died. These fatal results rendered the practice unpopular, and at one time the inoculation hospital in Boston was closed by order of the Legislature. Toward the end of the century an inoculating hospital was again opened in that city.

Early in the eighteenth century inoculation was extensively practiced by Dr. Adam Thomson, of Maryland, who was instrumental in spreading a knowledge of the practice throughout the Middle States.[2]

In China and India, and perhaps other eastern countries, inoculation was practiced at a very early period.

The inoculation of variolous matter, although it mitigated to a very great degree the attack of small-pox following, had one very serious objection, aside from the small death-rate which was a direct consequence of it. This was the fact that inoculation always produced small-pox, and thus assisted in propagating the disease; for, however mild the induced disease might be, the inoculated individual was liable to communicate small-pox to others in the most virulent form. Hence, nothing short of universal inoculation, which was manifestly impracticable, would succeed in reducing the danger from the disease.

Vaccination.—It had been noticed at various times that a pustular disease which sometimes appears on the udders of cows, called cow-pox, had not infrequently been transmitted to the hands of the dairy-maids and others having much to do with

[1] Dr. John R. Quinan (Md. Med. Journ., June 23 and 30, 1883) believes the claim of Dr. Boylston to be the first American inoculator open to question. The evidence presented is, however, insufficient to discredit the claim of the Boston physician.

[2] See Quinan, *loc. cit.*, p. 114.

cows. In course of time it was also noticed that persons who had been thus attacked never suffered from small-pox. This protective power of cow-pox was known as early as 1713, and in 1774 Benjamin Jesty, a Gloucestershire farmer, performed vaccination for the first time on record, inoculating his wife and two sons with cow-pox matter as a protection against small-pox.

It is stated that when it became known that Jesty had vaccinated his wife and sons, "his friends and neighbors, who had hitherto looked upon him with respect, on account of his superior intelligence and honorable character, began to regard him as an inhuman brute, who could dare to practice experiments upon his family, the sequel of which would be, as they thought, their metamorphosis into horned beasts. Consequently the worthy farmer was hooted at, reviled, and pelted whenever he attended the markets in his neighborhood."[1]

In 1791 a school-teacher in Holstein also inoculated three boys with the matter of cow-pox, but nothing is known of the subsequent history of these cases.

Although the above facts are clearly established, it is to Edward Jenner, a modest country doctor of Berkeley, in the county of Gloucester, England, that the merit of demonstrating the protective power of cow-pox against small-pox, and of diffusing a knowledge of this fact, is due. Jenner had his attention directed to the asserted protection conferred by cow-pox during the period of his apprenticeship. After a residence in London as a pupil of John Hunter, he returned to the country to practice his profession. About the year 1776 he began studying the question, and gathering evidence of the protection afforded against small-pox by the accidental inoculation of cow-pox virus. For twenty years he studied the subject, patiently awaiting an opportunity to put his belief to the test of experiment. On the 14th of May, 1796, he made his first vaccination on a boy named James Phipps. Six weeks later he inoculated this boy with variolous matter, but without success, no small-

[1] London Lancet, September 13, 1862.

pox resulting. Two years later he published his pamphlet, entitled "An Inquiry into the Causes and Effects of the Variola Vaccinæ, etc.," in which he detailed his observations and experiments. This publication produced a great sensation in the medical world, and, although much opposition was at first manifested toward his views, he soon gained many adherents.

Vaccination, as the operation for the inoculation of cow-pox virus is termed, was rapidly introduced into all civilized countries, and soon demonstrated its good effects by greatly restricting the prevalence of small-pox. It is generally believed that the first one to practice vaccination in this country was Dr. Benjamin Waterhouse, of Boston, in the summer of 1800; but Dr. John R. Quinan has recently shown[1] that vaccination was introduced into Maryland, by Dr. John Crawford and Dr. James Smith, at least as early as the date generally assigned for its introduction into Massachusetts.

It was believed by Dr. Jenner, and was afterward conclusively shown by a number of distinguished experimenters, that vaccinia, as the disease produced by cow-pox inoculation was called, was merely a modification of small-pox as it existed in the cow. Small-pox virus, when inoculated upon the cow, produced cow-pox; but the latter, re-inoculated upon man, produced cow-pox (vaccinia), and not small-pox. Sheep-pock and horse-pock, or "grease," are probably merely modifications of the disease produced by inoculating small-pox into those animals.

When cow-pox virus is successfully inoculated into the human system—that is, when a person is successfully vaccinated—the following local and general symptoms are observed:—

In the case of a primary vaccination, *i.e.*, where the individual has not been previously vaccinated or attacked by small-pox, the point where the vaccination is made shows no particular change for the first two days. If the vaccination is successful, a small, reddish papule appears by the third day,

[1] Quinan, *loc. cit.*, pp. 118, 131.

which, by the fifth or sixth day, has become a distinct vesicle of a bluish-white color, with a raised edge and a peculiar, central, cup-like depression called the umbilication. By the eighth day this vesicle has become plump, round, and pearl-colored, the central umbilication being still more marked. At this time a red, inflamed circle, called the areola, appears, surrounding the vesicle and extending usually in a radius of from $\frac{1}{2}$ to 2 inches when fully developed. This inflammatory ring is usually pretty firm, and there is more or less general fever and often enlargement and tenderness of the axillary glands. After the tenth day the areola begins to fade, and the contents of the vesicle dry into a hard, brownish crust or scab, which falls off between the twentieth and twenty-fourth days, leaving a punctated scar, which gradually becomes white.

When the vaccinia has passed through all of these stages, especially if the vesicle filled with pearly lymph, and the areola have been well developed, the vaccination may be considered a success, and the individual protected against small-pox for a number of years, if not for life. Recently the doctrine has been strongly advocated that vaccination is not absolutely protective until a subsequent inoculation of vaccine fails to "take." According to this view, vaccination should be repeated until it fails any longer to exhibit any local reaction. When this has been attained the individual may be considered absolutely protected for life. Theoretically, this view has much in its favor, but there is, as yet, not sufficient evidence to establish it as a law.

It may be stated as an established fact that vaccination, although carefully performed and successful, does not confer absolute immunity from small-pox for life. The protective power seems to wear out after a time and the individual then again becomes susceptible to small-pox. An attack of small-pox in a vaccinated individual is, however, nearly always much milder than where there had been no vaccination. There is no fact in the entire range of medicine better established than this:

that small-pox in vaccinated persons is a much less dangerous disease than typhoid fever, while in unvaccinated cases the mortality ranges from 30 to 40 per cent. An approximate guide to the beneficent influence of vaccination upon the mortality from small-pox is furnished by a table in Seaton's report on vaccination. Before the introduction of vaccination the mortality from small-pox, per million of inhabitants of England, was nearly 3000 per year. After the introduction of vaccination the mortality was reduced to 310 per million per year.

The most remarkable and convincing statistical evidence on the question is given by Drs. Seaton and Buchanan, of England. During the small-pox epidemic in London, in 1863, they examined over 50,000 school-children, and found among every thousand without evidence of vaccination 360 with scars of small-pox, while of every thousand presenting some evidence of vaccination only 1.78 had any such traces of small-pox to exhibit.[1] The reliability of general mortality statistics may be called in question—in some cases, with justice; but the significance of these figures cannot be evaded.

The upper and outer surface of the arm is usually chosen as the point where the virus is inserted, although any part of the body which can be protected against friction, or other mechanical irritation, may be selected. The method varies slightly in the hands of different vaccinators. The two methods most frequently in use are scarification and erasion. The former method has the indorsement of Mr. Seaton, the high English authority. The method of erasion—scraping off the epidermis until the papillary layer of the skin is laid bare—is now most frequently used in this country. The best instrument to use is a clean thumb-lancet; in default of this, an ordinary sewing-needle answers well. Where animal vaccine is used, the ivory slip or sharpened quill may also be used with satisfaction to make the scarification or erasion. Whatever instrument is used, it should always be kept perfectly clean.

[1] Seaton, "Vaccination," in Reynolds's System of Medicine, vol. i, p. 291. Second edition.

A point of vital importance is that which relates to the proper age at which children should be vaccinated. Ordinarily, vaccination should be performed within the first six months of life. In time of danger from a threatened, or in the presence of an actual, epidemic, infants may be vaccinated when only 1 day old.

In order to secure permanent protection against small-pox, revaccination should be performed after a certain interval. Some place the period at which this second vaccination should be done at five years, while others allow a longer interval—seven, eight, or ten years. The law of Prussia is that every child that has not already had small-pox must be vaccinated within the first year of its life, and every pupil in a public or private institution is to be revaccinated during the year in which his or her twelfth birthday occurs.

This law was passed in 1874. Prior to this time the mortality from small-pox was 15 to 20 per 100,000 of the population. Since the law was enacted the small-pox mortality has varied from 0.3 to 3.6 per 100,000. Not a single death from small-pox occurred in the German army between 1874 and 1882.[1]

A revaccination, even if successful, seldom passes through all the typical stages of a primary vaccination. The vesicle rarely becomes so full and plump, and is more frequently flat and irregular in outline. Swelling of the axillary glands and other complications also seem to be more frequent than in cases where the vaccination is done for the first time.

The question whether the lymph direct from the cow or humanized lymph is the more efficient has caused much discussion. The objections urged against the use of humanized virus are: first, that its protective power has become diminished by transmission through many generations; second, that it is liable to transmit other diseases, such as syphilis, tuberculosis, scrofula, etc.; third, that it is frequently difficult to obtain in

[1] Frölich, Militär-Medicin, p. 461.

sufficient quantities in an emergency, such as an actual or threatened epidemic.

The first objection is disproved by the testimony of many of the most distinguished medical men in Europe and this country. Humanized vaccine virus, when properly inoculated, seems to be as completely protective against small-pox as that taken direct from the animal. Among its advantages are, that it "takes" more readily and runs through its stages of development in a shorter time, and that it will retain its active properties for a greater length of time than animal virus. The physician can usually control the source whence he obtains it. He can watch over the subject that furnishes it and reject that which is suspicious. With humanized lymph collected by the physician himself there can be no doubt as to its purity or age; with animal lymph furnished by the cultivators of that article there can be no certainty about either of these important points.

That syphilis has been inoculated with humanized virus can no longer be open to doubt. The recent experiment of Dr. Cory, of England, has settled this question definitely. With care, however, this sad accident can easily be avoided, and the fact that syphilis has been so rarely transmitted by vaccination is sufficient evidence that the danger of such infection is not very great.

The most serious objection against the exclusive use of humanized lymph is, that in grave emergencies, such as a rapidly-spreading epidemic of small-pox, it is difficult to obtain a sufficient supply of the lymph.

Humanized virus is inoculated, either in the fresh state, *i.e.*, the lymph is taken from the vesicle on the seventh day and inoculated directly into the arms of other individuals, or else the vesicle is allowed to dry into a crust, with which a thin paste is made by moistening with water at the time of vaccination. The readiest way of using the crust is to crush a small fragment between two small squares of glass, then moistening it with a drop of warm (not hot) water, and smearing it on the spot

where the vaccination is to be made. With the lancet a number of cross-scarifications are then made, and the virus well rubbed in. Only so much of the crust should be moistened as will be used at the time. Particular care must be taken not to use saliva for moistening the crust. Aside from being unclean, there is danger of producing blood-poisoning by inoculating certain of the oral secretions.[1]

Animal virus is obtained by inoculating a calf or heifer with virus, either derived from a case of small-pox, from another case of cow-pox, or by re-inoculating humanized vaccine virus into the animal. The vesicles are opened on the seventh day, and ivory points or the ends of quills coated with the lymph and dried with a gentle heat.

In vaccinating with animal virus, the quill or ivory point is first moistened with a drop of water to soften the adhering lymph; the scarification or abrasion of the skin is then made with the lancet, and the virus rubbed well into the scarified spot.

In using animal virus the successive stages of development are usually one or two days later than when humanized virus is used. In the former case the areola is rarely developed before the ninth day.

Certain complications are likely to occur in the course of the vaccinia, of which the student should be aware.

When the areola appears there is usually more or less fever. Sometimes the constitutional manifestations are decidedly marked, fever of a high grade being not uncommon. In addition to the glandular enlargement and tenderness, an outbreak of roseola sometimes comes on about the ninth or tenth day. This eruption may be mistaken for scarlet fever, but if it is remembered that two infectious diseases rarely coexist in one individual during their full development this error will be avoided.

Erysipelas involving the entire arm is sometimes observed

[1] See Sternberg and Magnin, Bacteria, p. 355. Second edition.

as a complication of vaccination. This, in nearly every case, depends upon some depravement of the patient's constitution, innutrition, bad sanitary surroundings, or, perhaps, more frequently, chronic alcoholism. Individuals who are habitually intemperate in the indulgence of alcoholic liquors are especially unfavorable subjects for vaccination. The results are, fortunately, rarely serious to the patient.

Another inconvenient complication of vaccination is the formation of a deep, ill-looking, sloughing ulcer at the vaccinated point. This has been, in the author's experience, a much more frequent concomitant when animal virus has been used than when humanized virus was resorted to. It should be borne in mind that a very sore arm, especially if followed by the formation of an ulcer or gangrenous sore, may not be protective against small-pox. Such a patient should not be considered properly vaccinated, and must be revaccinated as soon as he recovers, or immediately if there is any danger of small-pox infection.

Children with eczematous eruptions, however, localized upon any portion of the body, should not be vaccinated until the eruption is first cured, except in times of danger from small-pox. The eczema will be almost certainly rendered worse in consequence of the general hyperæmia accompanying the febrile reaction, and the physician who performs the vaccination will be blamed for causing the skin disease.

The author has placed on record[1] two cases of general psoriasis following vaccination, and other cases have been since reported. Urticaria and exudative erythema have also been repeatedly observed.

As before stated, syphilis may be communicated to the vaccinee by vaccine virus obtained from a syphilitic subject, but this accident is infrequent. There can be little doubt that some of the cases reported as "vaccinal syphilis" are cases of tardy hereditary syphilis, lighted up by the general systemic disturbance following vaccination.

[1] Journal Cutaneous and Venous Diseases, vol. i, No. 1, p. 11.

Next in importance to vaccination in the prophylaxis of small-pox is prompt isolation of the sick. No one but the medical and other attendants of the sick should be allowed to come in contact with them. All attendants and other persons exposed to the infection should, of course, be promptly vaccinated, unless this has been successfully done within the previous year or two.

Disinfection of all discharges from the patient and of the room and its contents, after the patient has recovered or died, must be practiced. The best disinfectants in small-pox are bichloride of mercury, free chlorine, and sulphurous acid.

When it is learned that a person has small-pox, if he is not removed to a special hospital, a room should be prepared for his occupancy. The carpets should be taken up and the floor kept clean. Window-curtains and unnecessary furniture and drapery should be removed from the room. After recovery of the patient the bed-clothing must be thoroughly disinfected with steam or sulphurous acid, or destroyed by fire. The individual himself should not be allowed to mingle with healthy persons until all danger of infection is passed and the surface of his body has been thoroughly disinfected.

ASIATIC CHOLERA.

A disease which causes the death of three-fourths of a million of human beings in the country where it is endemic, within the space of five years, and which makes periodical excursions, spreading over nearly the entire inhabited globe with destructive violence, must surely command the interested attention of every intelligent person.

Asiatic cholera is an endemic disease of India, where it probably originated centuries ago. Some authors claim to have found satisfactory evidence of its existence in the writings of the classical authors of India and Greece at a period as early as the second century of the Christian era. The evidence is, however, not beyond question. In the sixteenth and seventeenth cen-

turies European travelers in the East gave pretty exact accounts of the disease. One of the most definite of these was given by Gaspar Correa, an officer in Vasco da Gama's expedition to Calicut. He states that Zamorin, the chief of Calicut, lost 20,000 of his troops by the disease. A still more definite and the first trustworthy account is that of Sonnerat, a French traveler. He describes a pestilence having all the characters now recognized as belonging to Asiatic cholera, which prevailed in the neighborhood of Pondicherry and the Coromandel coast in 1768 and 1769, and which carried off 60,000 of those attacked by it within a year. Dr. Macpherson, in his "History of Cholera," gives numerous references which indisputably establish the endemic existence of the disease in India anterior to the present century.

Being endemically prevalent over a greater or less area of India for many years, cholera finally, in 1817, crossed the boundaries of that country, and, advancing in a southeasterly direction, invaded Ceylon and the Sunda Islands in 1818. In a westerly direction the disease was carried to the islands of Mauritius and Réunion, and reached the African coast in 1820. During this year it also traveled northeasterly, devastating the Chinese Empire for the two following years, reaching Nagasaki, in Japan, in 1822.

In 1821 the disease spread from India in a westerly direction, extending along the east coast of Arabia to the border of Mesopotamia and Persia. In the spring of 1822 it began with renewed violence, following the river Tigris to Kurdistan, and, extending farther in a westerly direction, reached the Mediterranean coast of Syria. In the following year, 1823, it extended from Persia into Asiatic Russia, reaching Astrachan on the European border in September, but dying out nearly everywhere beyond the borders of India during the ensuing winter.

In 1826 cholera again advanced from India, reaching Orenburg in Russia in 1829, and in the following winter appeared in St. Petersburg. Extending to the north and south,

it invaded Finland and Poland the same year. From Persia the disease spread to Egypt and Palestine in 1830–31.

From Russia the pestilence invaded Germany in 1831, passing thence in 1832 into France, the British Isles, Belgium, the Netherlands, Norway, and Sweden. In the latter year cholera crossed the Atlantic Ocean for the first time, being carried to Canada by emigrants from Ireland, and spreading thence to the United States by way of Detroit. In the same year it was imported into New York by emigrants, and rapidly spread along the Atlantic coast. During the winter of 1832 it appeared at New Orleans, and passed thence up the Mississippi Valley. Extending into the Indian country, causing sad havoc among the aborigines, it advanced westward until its further progress was stayed by the shores of the Pacific Ocean. In 1834 it re-appeared on the east coast of the United States, but did not gain much headway, and in the following year New Orleans was again invaded by way of Cuba. It was imported into Mexico in 1833. In 1835 it appeared for the first time in South America, being restricted, however, to a mild epidemic on the Guiana coast.

While the pestilence was advancing in the Western Hemisphere, it also spread throughout Southern Europe, invading, in turn, Portugal, Spain, and Italy.

Extending in an easterly direction from India, the disease reached China and Japan in 1830–31; westwardly, Africa was invaded in 1834, and ravaged by the epidemic during the following three years.

This second extensive outbreak of cholera ended in 1837, disappearing at all points beyond the borders of India. In 1846 the disease again advanced beyond its natural confines, reaching Europe, by way of Turkey, in 1848. In the autumn of this year it also appeared in Great Britain, Belgium, the Netherlands, Sweden, and the United States, entering by way of New York and New Orleans. In the succeeding two years the entire extent of country east of the Rocky Mountains was invaded. During 1851 and 1852 the disease was frequently im-

ported by emigrants, who were annually arriving in great numbers from the various infected countries of Europe. In 1853 and 1854, cholera again prevailed extensively in this country, being, however, traceable to renewed importation of infected material from abroad. In the following two years it also broke out in numerous South American States, where it prevailed at intervals until 1863.

Hardly had this third great pandemic come to an end before the disease again advanced from the Ganges, spreading throughout India, and extending to China, Japan, and the East India Archipelago during the years 1863 to 1865. In the latter year it reached Europe by way of Malta and Marseilles. It rapidly spread over the Continent, and in 1866 was imported into this country by way of Halifax, New York, and New Orleans. This epidemic prevailed extensively in the Western States, but produced only slight ravages on the Atlantic coast, being kept in check by appropriate sanitary measures. In the same year (1866) the disease was also carried to South America, and invaded, for the first time, the States bordering on the Rio de la Plata and the Pacific coast of the Continent.

While the epidemic was thus advancing westward from its home in India, it was at the same time spreading northwardly over the entire western part of Asia, and in a southeasterly direction over Northern Africa. In the latter continent it prevailed from 1865 to 1869.

Cholera never entirely disappeared in Russia during the latter half of the sixth decade, and in 1870 it again broke out with violence, carrying off a quarter of a million of the inhabitants before dying out in 1873. It spread from Russia into Germany and France, and was imported, in 1873, into this country, entering by way of New Orleans and extending up the Mississippi Valley. None of the Atlantic-coast cities suffered from the epidemic in 1873, and since that year the United States have been entirely free from the disease, with the exception of a few imported cases in New York Harbor in 1887.

In June, 1883, a new epidemic of cholera broke out in Egypt, where it raged with great violence. The disease first appeared in Damietta, near the outlet of the Suez Canal. It was unquestionably imported from India, probably Bombay, where it prevailed as early as the month of May. At the time of the outbreak in Damietta that city was overcrowded with people who had come to attend a great religious fair and festival. It has been proven that pilgrims from Bombay were among the attendants at this fair. The epidemic came to an end in Egypt in the autumn of 1883. In the same year (1883) a small outbreak occurred in Marseilles, but intelligence of it was carefully suppressed by the authorities. The disease does not seem to have spread from this centre, but in June of the following year cholera broke out in Toulon, having probably been imported in a transport ship returning from Tonquin. This outbreak was very violent and rapidly spread throughout Southern France, Italy, and Spain. After apparently dying out during the winter, it re-appeared in the spring of 1885 with renewed violence. The total number of cases in Spain alone in the latter year was over one-third of a million, with nearly 120,000 deaths.

In the summer of 1885 cholera also broke out in a virulent form in Japan, and, after a cessation during the following winter, recurred with increased fatality in 1886. In the latter year there were over 100,000 deaths from the disease in that country.

During 1886 and 1887 cholera continued in Southeastern Italy and in the Austrian dominions at the head of the Adriatic. A few cases occurred in France and Germany, but by stringent sanitary measures an epidemic was averted.

In November, 1886, cholera was carried to South America in an Italian ship, the "Perseo," bound from Genoa to Buenos Ayres. The disease rapidly spread in the Argentine Republic, and, crossing the Andean range, invaded the Pacific coast of the South American continent for the second time, reaching Chili and Bolivia and threatening Peru and Brazil. In Chili alone

there were over 10,000 deaths in the first six months of 1887. The further progress of the epidemic was arrested and the entire Western Hemisphere is now free from the disease.

From July to December, 1889, cholera prevailed with considerable virulence in Mesopotamia. This epidemic seems, at the time of writing (February 1, 1890), to be at an end.

This brief historical sketch of all the epidemics of cholera observed beyond the borders of India demonstrates several facts: first, that the home or breeding-place of cholera is in India, especially the delta of the Ganges, whence it spreads at intervals throughout the world; second, that it always advances along the lines of travel of large bodies of human beings; and, third, that it advances, by preference, along water-routes. The latter is particularly noticeable in the behavior of cholera epidemics in this country. When it has spread from an Atlantic port, it has, generally, been to other places having water communication with that port. Exceptions undoubtedly occur, but the rule is a general one. The disease seems to spread with difficulty along the lines of railroad. When the disease has extended from New Orleans it has always been up the Mississippi Valley, expending its violence upon the river cities—Vicksburg, Memphis, St. Louis, and Cincinnati.

Several factors must concur before there can be an epidemic of cholera. These are: first, the cholera poison; second, certain local conditions of air, soil, or water; and, third, individual predisposition. Without a concurrence of all these conditions no outbreak can occur. If, by any means, the co-existence of these three conditions can be prevented, cholera can be averted. The following are facts bearing upon this question: Cholera is communicated through the agency of a specific poison. This does not admit of doubt. The poison may be either an organic germ, or of an inorganic, particulate, or gaseous nature. The recent researches of Dr. Robert Koch, of Germany, indicate that a micro-organism found in the intestinal discharges of cholera patients and in the bodies of those dead with the disease is the

active agent in propagating the malady. This organism, named by Koch the "comma bacillus," from its general resemblance to a comma, was first discovered by this eminent pathologist in the intestinal contents of cholera corpses in Egypt in 1883, and in the following year more thoroughly studied in Calcutta, whither he had been sent by the German government to pursue his investigations. It has been demonstrated that this germ is always present in the discharges of cholera patients, and up to this time it has not been found in any other disease. Experiments upon animals have also shown that cholera can be produced in the latter by introducing the germ into their bodies in various ways. The demonstration of the bacterial nature of cholera seems to be complete.

While cholera cannot be regarded as personally contagious in the same sense or in the same degree as small-pox, there can be no doubt that it is spread only by the poison from other cases of the disease. The regularity of its march along routes by which the intercourse of human beings takes place, and always in connection with other cases of cholera, proves this. There is no undoubted case on record where genuine cholera has been spontaneously developed outside of India.

That certain local geological and perhaps meteorological conditions are necessary for the propagation or virulence of the poison of cholera is beyond dispute. Outbreaks usually take place during the summer or autumn, and nearly always partly or entirely die out during cold weather. Further, in nearly all epidemics, certain cities or towns, or portions of a town, into which persons sick with cholera are brought, and where the poison of the disease is thus imported, remain exempt from the effects of the epidemic. The inference to be drawn from this fact is that in such localities the local conditions are unfavorable to the development of the poisonous germ, and it becomes inert.

In India all the local conditions favorable to the propagation of the cholera-germ are found. The filthy personal habits of the people, the overcrowding, the intense heat. the lack of suf-

ficient, appropriate, or properly-prepared food, and the extensive pollution of the water-supply, all combine to produce the necessary conditions of development of the cause of cholera. These conditions, doubtless, to a considerable extent, give rise to that depression of the system which seems necessary to constitute the individual predisposition to become infected.

Given, then, at any place, a number of persons of a lowered degree of vitality,—that is to say, persons not capable of resisting unfavorable influences upon their health under unfavoring conditions; given conditions of climate, water, and soil more or less similar to those existing in India: only the introduction of the third factor, the cholera poison, is needed to cause an outbreak. In many cities of this country and Europe, as proven by the most recent epidemics in Toulon, Marseilles, Naples, and other cities of Italy and Spain, the conditions are present which would furnish the most favorable breeding-place for the cholera-germ if introduced.

The dejections and vomited matters of cholera patients contain the active agent which produces the disease. The contagious principle contained in these excretions, probably the cholera-germ or "comma bacillus" discovered by Koch, may gain an entrance into the body through the drinking-water or through infected air. Probably both modes are equally competent channels of infection. The prevailing theory is that pollution of the drinking-water is the most frequent source of the rapid spread of the disease. A very striking instance of this occurred in London during the epidemic of 1854, which has already been referred to.[1]

Another striking instance of the communication of cholera by polluted water has been reported by Mr. John Simon, long the chief medical officer of the English "Local Government Board." The facts are as follow: The Lambeth Water Company drew its supply from the Thames, at Ditton, above the influence of the London sewage and the tidal flux. The Southwark and

[1] See *ante*, page 64.

Vauxhall Company drew its supply from the river near Vauxhall and Chelsea. The water of the Lambeth Company was tolerably pure, and that of the Southwark and Vauxhall Company was very impure. The water of both companies was distributed in the same district at the same time and among the same class of people, the pipes of the two companies being laid pretty evenly in the same areas, in many places running side by side in the same streets, and the houses supplied being pretty equally distributed. The deaths from cholera in the houses supplied by the Lambeth Company were at the rate of 37, and in the houses supplied by the Southwark and Vauxhall Company at the rate of 130, to every 10,000 persons living. It appears, therefore, that of the drinkers of the foul water about three and a half times as many as those who drank the pure water died of cholera.

But the spread of cholera cannot always be referred to pollution of the drinking-water. In many epidemics no relation can be shown to exist between the spread of the disease and impure water. Professor von Pettenkofer, of Munich, has shown, by a number of carefully-conducted observations, that the propagation of cholera often bears a very direct relation to changes in the stage of the subsoil- or ground- water. This does not mean that the subsoil-water is directly or necessarily the agent for the spread of the disease, but that its stage, or variability,—now high, now low,—may be considered as an index of certain processes going on in the soil which are intimately connected with the propagation of cholera as well as of certain other infectious diseases, chief among which is typhoid fever. The relations between the ground-water level and cholera outbreaks in India and various cities in Europe and America give strong support to the views of von Pettenkofer.[1]

In addition to the influence of the ground-water oscillations and polluted drinking-water in spreading the cholera-poison, must be mentioned articles of food contaminated with the infectious matter of the disease. It is also no longer open to

[1] See page 130.

question that persons may become infected by handling the clothing and bedding of cholera patients. Laundresses are in special danger from this source. Physicians and nurses have, not rarely, been attacked under circumstances which pointed strongly to personal contagion as one of the sources of the disease.

The prophylaxis against cholera comprises such measures as will prevent the admission of the cholera-poison into a community, arrest the development of the poison after its introduction, and reduce the individual susceptibility to attack.

It is evident from the foregoing that if the introduction of the cholera-poison could be prevented no outbreak of the disease could occur. With this in view, some have urged the enforcement of a strict policy of non-intercourse with infected localities. But at the present day few sanitarians advocate these extreme measures. A modified system of restricted intercourse is supported by many authorities, who claim that by the adoption of a thorough system of maritime inspection, disinfection, and observation—a rational quarantine, in fact—the poison can be rendered ineffective or its entrace into a commmunity prevented.

The best authorities, however, think that it is not only easier, but far more effective to place the threatened locality in such a sanitary condition that the development of the cholera-poison cannot take place. The contrast between the effectiveness of quarantine and local sanitation as safeguards against cholera has been well expressed by von Pettenkofer, who compares cholera epidemics to powder explosions. The virus of cholera, he says, is the spark that evades the strictest quarantine; the powder is the *ensemble* of local conditions which predispose to the outbreak. "It is wiser, therefore, to seek out and remove the powder than to run after and try to extinguish each individual spark before it drops upon a mass of powder, and, igniting it, causes an explosion which blows us into the air with our extinguishers in our hands."

The measures of local sanitation to be enforced are such as will secure cleanliness of person, of habitation and surround-

ings, of air, of water, and of soil. Pollution of the soil should be especially guarded against, for a polluted soil means impure air and water, and these mean, if not an infectious disease, at least a heightened receptivity to its influence. The quality of the drinking-water used must be above suspicion of contamination by the poison. Unless the latter can be positively excluded all drinking-water should first be boiled. It may then be cooled by pure ice. Filtering the water may not remove the poison.

The individual predisposition to cholera is best guarded against by keeping the body clean and well nourished, and the mind free from worry. Underfeeding, anxiety, overwork, exposure to extremes of temperature, intemperance in eating and drinking should all be avoided, as they tend to reduce the resistance of the system to the influence of the morbid poison.

Certain measures of personal prophylaxis which have proven useful heretofore should be adopted wherever cholera prevails. One of the best of these is the use of sulphuric-acid lemonade as a drink. Ten to 15 drops of dilute sulphuric acid in a glass of water, sweetened with sugar, may be drunk instead of water. Experience with it during the epidemic of 1866 has demonstrated its great value as a preventive of cholera. The later researches of Koch have also shown that the "comma bacillus," or spirillum, cannot live in acid solutions. Hence, it is probable that if the contents of the stomach were always kept acid no infection could occur through absorption from the stomach.

A painless diarrhœa, called cholerine, attacks many persons during cholera epidemics. This disorder is easily curable if promptly attended to, but if allowed to run on it may develop into a malignant attack of cholera.

Among the means of securing prompt treatment of the poorer classes in times of epidemics is the establishment of numerous public dispensaries, where medical aid can always be obtained. The establishment of such dispensaries and, if

possible, of temporary hospitals in the crowded portions of cities is a very important part of the prophylactic treatment.

Inasmuch as it seems definitely established that the discharges from the stomach and intestines are the active agents in propagating the disease, the immediate disinfection of such discharges is vitally important. The stools and vomited matters must be rendered innocuous by germicidal agents, such as mercuric chloride, carbolic acid, or chloride of lime.

Clothing and bedding should be disinfected with superheated steam, thorough boiling, or fumigation with sulphur dioxide or chlorine. Infected articles of this kind should not be sent to a laundry until they have been thoroughly disinfected by one of the above-mentioned means.

Apartments which have been occupied by cholera patients should be thoroughly fumigated, before being re-occupied, with burning sulphur, and afterward freely exposed to the air by opening doors and windows. The walls may also be washed with a solution of mercuric chloride.

The most efficient disinfectant is mercuric chloride in the proportion of 1 part in 2000 of the material to be disinfected. The readiest way of securing disinfection with this agent is to add a solution of 1 to 1000 to an equal proportion of the discharges to be rendered innocuous. The mercuric chloride acts slowly, and hence the infected material should be exposed to the action of the disinfecting agent for at least two hours before it can safely be thrown into sewers or cess-pools.

There are several serious objections to the indiscriminate use of mercuric chloride by the public as a disinfectant. In the first place, it is intensely poisonous, and its perfectly transparent and inodorous solution might readily be accidentally drunk and cause fatal results. To reduce this danger, the Committee on Disinfectants of the American Public Health Association recommended the addition of permanganate of potash or of sulphate of copper (blue vitriol) to color the solution. Another serious objection to mercuric chloride is that it cannot be used where

the disinfected material must pass through lead pipe, as this is rapidly corroded by the sublimate. In many water-closets it can therefore not be used.

Chloride of lime (bleaching-powder) has been found to be a very rapid and efficient disinfectant, as well as a deodorizer; but the chlorine, upon which its effectiveness depends, is often so deficient in proportion, and the compound so readily deteriorates that, unless a preparation can be obtained that contains at least 25 per cent. of available chlorine, it may prove injurious by causing a false sense of security. A trustworthy preparation may be dissolved in water, when required, in the proportion of 1 to 100. An objection to its use is the pungent odor of chlorine, which is very offensive to many persons.

Dr. Koch recommends carbolic acid, which he has shown will kill the "comma bacilli" in a dilution of 1 to 20 of water. The ordinary preparations of carbolic acid sold as disinfectants are, however, not to be relied on, many of them not containing more than 2 per cent. of the acid. Further dilution of these agents would altogether destroy their disinfecting power. The purer article is, on the other hand, too expensive to be used as a disinfectant.

Little's soluble phenyle is an efficient disinfectant in the proportion of 2 per cent. (1 to 50). It is furnished of uniform strength, is moderately cheap, non-poisonous, and readily miscible with water. In addition to its disinfecting power, it is also an excellent deodorizer, promptly removing all odors of decomposition and putrefaction. Its only objection is a rather pungent though not unpleasant odor, which somewhat resembles creasote.

In the very beginning of an epidemic, prompt isolation of the sick and thorough disinfection of the surroundings of the patient may check the spread of the disease. Much cannot be expected from these measures, however, unless the local sanitary conditions are such as offer a hindrance to the development of the cholera-poison. It is plain, therefore, that prophylactic measures

against cholera, to be effective, must be brought into requisition before the epidemic has begun. After the outbreak of the disease it may be too late to put the threatened locality in a good sanitary condition. It is of the highest importance that preventive measures be enforced early.

RELAPSING FEVER.

Relapsing fever was first clearly described by Dr. John Rutty, in his "Chronological History of the Weather, Seasons, and Diseases of Dublin from 1725 to 1765."[1] Near the end of the last and in the first half of the present centuries relapsing fever was frequently met with in an epidemic form in Ireland and Scotland. In 1847 the disease invaded a number of the larger cities of England. From 1868 to 1873 it prevailed extensively in England and Scotland. On the continent of Europe it was first observed in Russia in 1833. In Germany it was not recognized as a distinct disease until 1847, but did not prevail epidemically until 1868. Since then it has often been observed in that country.

Relapsing fever is very prevalent in India, where it was first observed in 1856 by Sutherland. In China and in the countries of Africa bordering on the Red Sea the disease has been recognized by observers.

In the United States it was first observed among emigrants in Philadelphia in 1844, and again in 1869. It was conveyed to other places, but has never prevailed extensively in this country. It has not been observed in the United States since 1871.

The predisposing causes of relapsing fever are, above all, bad sanitary surroundings. Want and overcrowding seem to be much less important factors than in typhus fever.

Although relapsing fever has, since it was first clearly distinguished from typhus and other continued fevers, been recognized as an eminently contagious and infectious disease, it was

[1] London, 1770.

not until 1873 that its immediate cause became known. In that year Obermeier discovered in the blood of patients ill with this disease a minute, spiral, mobile organism, now known as the *spirillum* or *spirochæte Obermeieri.*

Obermeier and other observers, prominent among whom is Dr. Henry V. Carter, have demonstrated the constant presence of these organisms in the blood during the attack. Carter and Koch have induced the disease in monkeys by inoculation of the parasite, and Moschutkowski has successfully inoculated it in the human subject. No doubt can exist at the present day that the spirillum of Obermeier is the true cause of relapsing fever.

The preventive measures consist in attention to details of personal hygiene; in other words, local sanitation, disinfection of infected materials (fomites), and complete isolation of the sick.

TYPHOID FEVER.

The first accurate clinical accounts of typhoid fever date from the seventeenth century, when Baglivi, Willis, Sydenham, and others described cases of fever which in their clinical characters correspond to the disease now known as typhoid fever. Strother, however, in 1729, first gave a description of the anatomical characters of the disease, which he says is a "symptomatical fever, arising from an inflammation, or an ulcer, fixed on some of the bowels." Bretonneau and Louis, in France; Hildenbrand, in Germany; William Jenner, in England; and Drs. Gerhard and Pennock, in this country, clearly pointed out the essential distinction between typhoid and other fevers, during the first half of the present century.

At the present day typhoid fever is met with everywhere throughout the world. It is at nearly all times a constituent of mortality tables. It affects by preference persons between the ages of 15 and 30 years, although no age is entirely exempt. It is always more prevalent in the autumn and winter.

The disease is probably due to an organic poison, which gains entrance into the body through the respiratory or digestive

tract. Recent observations of Klebs and Eberth seem to indicate that the morbific agent is a micro-organism termed the *bacillus typhoideus*. The exact relation of this organism to the disease has not been clearly worked out. It is found in the intestinal canal, and especially in the characteristic intestinal lesions of this fever. The infective agent is probably contained in the dejections of patients. The disease is not immediately contagious, like typhus fever.

The medium through which the poison is introduced into the body may be drinking-water, food, milk, or other articles containing the infective agent. Localized epidemics due to infected water or milk have been frequently reported.[1]

The typhoid poison is supposed to be developed in cess-pools, sewers, and soil polluted by the products of animal decomposition. Whether it ever originates *de novo* in such places is a much-disputed proposition. At present the evidence is in favor of the view that cases of typhoid fever are always derived from pre-existing cases. The germ may develop in sewers and be carried in the sewer-air from place to place; it may be carried into the soil from cess-pools receiving typhoid dejections, and there, undergoing development, may ascend through houses with the ground-air, or may drain into wells and pollute the drinking-water. By the admixture of such water with milk or other food the disease may be propagated. It is also believed that the effluvia from typhoid discharges may be absorbed by water or milk, and thus infect these articles.

The prophylactic measures against typhoid fever comprise isolation of the sick, prompt disinfection of the discharges, and cleanliness in the widest sense. The water- and food- supplies must be carefully guarded against contamination with the poison, and all decomposing animal matter and excreta must be removed from the immediate vicinity of dwellings. The requisites for prevention may be summed up as pure air, pure water, uncontaminated food, and a clean soil.

[1] See *ante*, pp. 61-64.

TYPHUS FEVER.

Wide-spread pestilences are nearly always accompaniments of famine and war. Of all pestilential diseases, none is so regular in its coincidence with these conditions as typhus fever. The earliest accounts which unquestionably refer to this disease date from the eleventh century, when it was observed at a number of places in Italy. In the succeeding centuries isolated accounts of it appeared in the chronicles of the times, but no scientific description of it appeared until the sixteenth century. During the seventeenth, eighteenth, and the early part of the nineteenth centuries it prevailed extensively throughout Europe. The constant wars and consequent disturbances of the social relations of the people, famines, overcrowding, filth, excesses of all kinds, contributed largely to the development and spread of typhus fever. For a number of years past no extensive epidemic of the disease has been observed, although both in this country and in Europe localized outbreaks are frequently met with.

Typhus fever is somewhat more prevalent in the winter and early spring months than during the rest of the year, but not very markedly so.

At present, typhus fever is nearly always limited to times and places where the conditions favoring its development exist. Wherever overcrowding, in connection with filth, insufficient food, and bad habits are present, typhus fever is likely to be a visitor. Thus, in overcrowded and ill-ventilated emigrant ships, in jails and work-houses, and in camps, especially when stress of weather compels the crowding together of soldiers in close huts or barracks, the disease frequently breaks out.

When typhus fever appears in a community, those classes of the people who are subjected to the conditions just mentioned are almost exclusively attacked. In cities, the dwellers in crowded tenements, or in courts and alleys, suffer most severely—are, in fact, almost the only ones attacked. An exception must, however, be made in the case of hospital physicians and attend-

ants where typhus-fever patients are treated. The mortality among these is always large.

Typhus fever is contagious and infectious. An exposure for a length of time to an atmosphere impregnated with the poison may suffice to induce an attack. The poison may also be conveyed from place to place in fomites. Physicians may carry it in their clothing, if they have been exposed to a typhus atmosphere.

The prevention of typhus fever consists in the institution of such measures as will secure pure air, pure water, a clean soil and dwellings, and cleanliness of body and clothing. When an outbreak occurs, the sick should be promptly isolated, the well persons removed from the building in which the cases have occurred, and efficient measures of disinfection carried out. The sick should be treated in the open air as much as possible.

YELLOW FEVER.

The West India Islands, the Gulf coast of Mexico, the northern part of the Atlantic coast of South America, and a limited section of the west coast of Africa constitute the present home of yellow fever. From this area (the so-called "yellow-fever zone") the disease is frequently transported to contiguous or distant countries. The South Atlantic and Gulf coasts of the United States and the shores of the Caribbean Sea are most liable to the epidemic visitation of this pestilence.

The first trustworthy account of an epidemic of yellow fever dates from the year 1635, when it prevailed on the Island of Guadeloupe. This and the adjoining islands of Dominica, Martinique, and Barbadoes were invaded a number of times in the fifty years following the above date. Jamaica was invaded in 1655 and Domingo the year after. In 1693 the first appearance of the disease is mentioned in the United States, being observed in Boston, Philadelphia, and Charleston. In 1699 it appeared as an epidemic in Vera Cruz, and re-appeared in Philadelphia and Charleston. Since the year 1700, the disease has

appeared in an epidemic form, at one or more places within the present limits of the United States, eighty times, the last considerable invasion being at Jacksonville and other places in Florida, and Decatur in Alabama, in 1888.

In South America yellow fever appeared for the first time in 1740. In 1849 the disease was imported into Brazil, and has since then been endemic. Peru and the Argentine Republic have also suffered several severe visitations of yellow fever since 1854.

On the west coast of Africa, yellow fever seems to be endemic in the peninsula of Sierra Leone, where it has been frequently observed since 1816. It has also prevailed epidemically in Senegambia and a number of the islands off the northern portion of the west African coast. In Europe, Spain and Portugal have been the only countries to suffer from yellow-fever epidemics.

Although the causes of yellow fever cannot be definitely stated, it is well-known that it only occurs endemically within the tropics, and prevails epidemically elsewhere only during the summer. Of 180 epidemics observed in the United States and Bermudas, 154 began in July, August, and September. Of the remaining 26, none began in the six months from November to April.

A temperature of 26° C. and a high humidity are generally considered essential to produce an outbreak of the disease. Of other necessary meteorological conditions nothing is known.

That the specific cause of yellow fever is a micro-organism appears probable from a consideration of the clinical history of the disease and its mode of propagation. Up to the present time, however, none of the various organisms described as causative have made good the claims advanced by their discoverers. It can be stated without reserve that neither the organism of Freire, of Carmona, of Babes, of F. S. Billings, of Finlay, or of Gibier, is the true cause of yellow fever.

It seems to be well established that the most filthy and

insanitary portions of cities are those principally ravaged by yellow fever. The author is convinced from personal observation in Savannah, Memphis, and New Orleans, that filth is one of the principal factors in the spread of yellow fever. This opinion is also forcibly expressed by many of the most eminent authorities on the subject.

Yellow fever is not endemic within the limits of the United States, and has probably never originated here. The instances in which it has appeared to do so may be explained by the persistence of the morbific agent through one or more winters, or by a new importation which has escaped observation.

Yellow fever frequently breaks out on shipboard and causes much loss of life. There is no evidence that it originates on ships; it is only acquired after intercourse with an infected ship or infected place.

The question of the personal contagion of yellow fever has been decided negatively. The disease is infectious and its cause may be transported in fomites, but persons sick with the disease do not communicate it. An infected atmosphere, or one favorable to the poison, is necessary to the propagation of the disease.

The preventive measures indicated against yellow fever appear from the foregoing: they are strict sanitary inspection to prevent the introduction of a person sick with the disease; to prevent the introduction of clothing or other fomites from a suspected locality without thorough disinfection, and such a condition of public and private sanitation as will prevent the development of the poison, should the latter, perchance, be introduced.

When the disease becomes epidemic in a city, the inhabitants should be removed to temporary camps beyond the infected area. The experience of the city of Memphis in 1879, and of various localities in Florida in 1888, encourages the hope that by prompt depopulation of cities and strict enforcement of sanitary measures in the camps the terrors of yellow fever can be largely averted. The sick should be promptly isolated, and no one except attendants permitted to have intercourse with them.

SCARLET FEVER AND MEASLES.

The early history of these two contagious eruptive fevers is inextricably blended together. Up to the latter half of the seventeenth century the distinction between the two was not made by writers. Sydenham was among the first who clearly separated scarlet fever from measles and gave it a distinct name. Since the great English Hippocrates, the essential character of scarlet fever has been recognized by all physicians, and it is now never, or but rarely, confounded with measles.

Of the two diseases, measles is somewhat more generally prevalent, although both occur usually in epidemics. There is hardly a country in which measles has not been observed, while the continents of Asia and Africa have remained measurably exempt from scarlet fever up to the present time, although epidemics have been recorded in India and Japan.

Hirsch states that scarlet fever was first observed in this country in 1735, at Kingston, Mass., quoting as authorities Dr. Douglass, of Boston, and Dr. Colden, of New York. The latter, however, in a letter to Dr. Fothergill,[1] clearly describes diphtheria, and not scarlet fever. Its distribution is now general, but it is said to be much milder in the southern than in other portions of the United States. The prevalence of measles is not limited to any geographical section.

Epidemics of measles usually begin during cold weather. Of 530 epidemics observed in Europe and North America, 339 occurred during the colder and 191 during the warmer months. In 213 of these, the height of the epidemic occurred 135 times in winter and spring, and only 78 times during summer and autumn. Scarlet fever epidemics occur more frequently in autumn than at any other season.

The cause of scarlet fever or of measles is not to be sought in climatic influences, insanitary surroundings, or special natural conditions of air, water, or soil. Both diseases are contagious and infectious, and the contagion is transmitted either

[1] Medical Observations and Inquiries, vol. i, p. 211. London, 1776.

by fomites (clothing, letters, etc.), infected air, drinking-water, or milk.

Several observers have claimed the discovery of the specific organism of scarlet fever, but no trustworthy evidence has yet been furnished that the problem is solved. On a previous page (93) reference has been made to the probable connection between a disease of milk-cattle and scarlet fever.

The measures for the prevention of both diseases are isolation and thorough disinfection.

DIPHTHERIA.

Under the names of Syriac and Egyptian ulcers, Aretæus, a writer of the second century, described various forms of malignant sore throat. The disease now called diphtheria prevailed at various places in Europe during the Middle Ages. In this country it was first observed about the middle of the last century, and in 1771 Dr. Samuel Bard, of New York, described it very accurately. Although repeated severe outbreaks occurred in Europe in the early part of the present century, it was not until 1857 that it again attracted attention by its epidemic prevalence in the United States. Since that time it has spread throughout the country, and is at present one of the most generally diffused, as well as one of the most fatal, of the contagious diseases. In certain epidemics its malignancy is very marked, while in others it seems to be a rather mild affection.

Diphtheria is personally contagious; it may be transmitted by inoculation, as well as by inhaling an infected atmosphere. The virus is supposed by some investigators to dwell in a micro-organism, but no agreement has been reached as to the character of the specific microbe.[1]

The question as to the identity of diphtheria and croup is not merely a clinical one, but has an important bearing upon preventive medicine. If croup is a non-contagious and non-infectious disease, as is held by many, no precautions will be

[1] Wood and Formad, Klebs and Löffler, Emmerich, and T. Mitchell Prudden.

necessary to prevent its spread to healthy persons. If, on the other hand, diphtheria and croup are identical in nature, the danger of infection is equally great in both diseases. Inasmuch as it is frequently impossible to positively decide upon a diagnosis, it would be well to consider the identity of the two diseases as established, and act, as far as preventive measures are concerned, as if all were cases of diphtheria.

Diphtheria is inoculable upon animals, and may through this medium be transmitted to man.

Persons sick with diphtheria should be carefully isolated; no one but the immediate attendants should be allowed to come in contact with the patients. Table utensils, bedding, and clothing used by the sick should be thoroughly disinfected by steam or boiling water before being used by others. Intimate contact with the sick, such as kissing, should be strictly prohibited. There seems no room to doubt that the virus of the disease can also be carried in the clothing. Hence, physicians and nurses should be especially careful in personally disinfecting themselves after contact with a case of diphtheria. After death or recovery of the patient, the apartment occupied during the illness should be disinfected with chlorine or sulphurous-acid gas.

Children recovering from diphtheria, scarlet fever, measles, or small-pox, should not be permitted to attend school for at least four weeks after recovery. It is believed that there is danger of infection for a period about as long as this, and, besides, the patients are apt to be weakened from the effects of the disease, and not able to resist the strain of continuous mental effort.

DENGUE.

The disease known as break-bone fever, dandy fever, and by various other names, was first observed in the United States in 1780 by Dr. Benjamin Rush. Dr. Rush describes an epidemic which prevailed during the summer and early autumn of that year under the name of "bilious remittent fever," but the symptoms of the disease hardly leave any doubt that it was

dengue. In 1779 and 1780 it was also observed on the Coromandel coast, in Egypt, and on the island of Java. In 1784 to 1788 dengue also prevailed in various cities of Spain. In 1818 an epidemic appeared in Lima, in which nearly every one of the 70,000 inhabitants was attacked.

In 1824–25 the disease again prevailed widely in India, where it was known as the "three-day fever." Isolated outbreaks occurred in that country until 1853, when it again appeared as a wide-spread epidemic, and in 1872 another epidemic outbreak occurred in the East, extending from Eastern Africa to Arabia, India, and China.

In 1826 an epidemic of dengue appeared in Savannah, and in the following two years spread over the southern portion of the United States and the West Indies, reaching the northern coast of South America. In 1845 to 1849 the disease was observed in Rio Janeiro; in 1848 to 1850 in the South Atlantic and Gulf States. In 1854 it was observed in Southern Alabama, and in the same year in the West Indies. In 1873 another epidemic appeared in the lower Mississippi Valley, and in 1880 an outbreak of some extent occurred in New Orleans, Charleston, and other places on the Gulf and South Atlantic coasts.

Dengue always begins in the summer or early autumn, and ceases abruptly with the advent of cold weather. It is almost exclusively limited to hot countries. It spreads with extreme rapidity wherever it appears. It is not contagious; the manner of its propagation is not known. The susceptibility to the disease appears to be almost universal; it frequently prostrates the majority of the inhabitants where an outbreak occurs. During the epidemic in Calcutta in 1871–72, 75 per cent. of the population were attacked. In the United States similar epidemics have been repeatedly observed.

Dengue is rarely fatal. It seems to be propagated through the atmosphere. No measures of prevention are known or available.

EPIDEMIC INFLUENZA.

Accounts of epidemic influenza can be traced back to the year 1173, when the disease was observed coincidently in Italy, Germany, and England. It has prevailed epidemically, at varying intervals, to the present time. In the fourteenth century 3 epidemics are recorded; in the fifteenth, 4; in the sixteenth, 7; in the seventeenth, 46. Of these, 15 were very extensive, some of them prevailing over both hemispheres contemporaneously.

On the American continent influenza was first recorded in 1627, when it prevailed in New England, where it again broke out in 1625. Following this there is no notice of the disease in America until 1732, when an epidemic began in the New England States, which extended over the entire globe. Epidemics occurred during the remainder of the eighteenth century in 1737, 1757, 1761, 1767, 1772, 1781, 1789, and 1798. During the present century the disease has prevailed more or less extensively in this country at thirteen different times, the last epidemic of any considerable extent being in 1879.

At the time of writing (February, 1890) a very widespread epidemic, which began in Russia in November, 1889, is prevailing in the United States, complicated in many cases by pneumonia of a fatal character. The disease manifests itself in two principal forms, the catarrhal and the nervous. Weichselbaum, of Vienna, claims to have discovered a micro-organism which he believes to be the cause of the affection, but this claim has not yet been verified.

A curious feature of epidemics of influenza is the coincident occurrence of outbreaks of a somewhat similar affection among animals, horses and dogs being especially attacked.

Influenza is an acute, specific, infectious disease, not directly contagious. The infection is apparently produced or transmitted in the air. The disease frequently appears over a large area of country almost simultaneously. Peculiarities of climate, season, meteorological conditions, geological formation, or racial

characteristics have no apparent influence upon the causation or spread of the disease. It occurs more frequently in the winter and spring than during the summer or autumnal months. The investigation into the epidemic of influenza among horses, referred to in a previous chapter,[1] seems to indicate, however, that a moist and impure atmosphere intensifies the disease.

No measures of prophylaxis can be indicated except avoidance of anything tending to depress the vital powers.

EPIDEMIC CEREBRO-SPINAL MENINGITIS.

This disease was first recognized in Geneva in 1805. In the following year it was noted in various places in the United States. Both in Europe and this country localized outbreaks of the disease occurred between the dates above mentioned and 1816. At this time the disease seemed to die out altogether, but in 1822 it re-appeared in various parts of Europe and America.

Cerebro-spinal meningitis appeared in 1857 in the southwest of France, and during the following ten years spread over a large part of the country. Algiers, Italy, Denmark, and Ireland were also visited by the scourge. In 1854 and 1861 Sweden experienced its ravages; and in 1859 Norway was invaded by the disease, which continued for nearly a decennium in the latter country. From 1860 to 1867 the disease prevailed in Holland, Portugal, Germany, Ireland, and Russia.

After the termination of what may be called the first epidemic, in 1816, cerebro-spinal meningitis was not again observed in this country until 1842. In the eight years succeeding, it prevailed epidemically throughout almost the whole United States. From 1861 to 1873 it was noted frequently in various parts of the country. Since the latter year the reports of its occurrence in this country have been limited to sporadic cases or localized outbreaks.

Cerebro-spinal meningitis is an acute infectious disease,

[1] Chapter I, p. 29.

very fatal in its tendency. It is probably not personally contagious. Climate has no influence upon its origin, but season seems to stand in a positive relation to its causation. About three-fourths of the epidemics noticed have occurred during the winter and spring months. The disease seems to show no preference for peculiarities of topographical or geographical formation. Overcrowding, overwork, and uncleanliness have an important influence in determining an outbreak. It is especially a disease of youth and adolescence. Out of 975 cases occurring in New York only 150 were over 20 years of age, while of the remainder 665 were under 10.

The prophylactic measures to be adopted against cerebro-spinal meningitis consist in careful attention to the sanitary conditions of dwellings and streets, avoidance of overwork and overcrowding during times of epidemic, isolation of the sick, and disinfection of the sick-room after the termination of the disease.

SYPHILIS.

In the year 1494, Charles VIII, of France, in command of a large army invaded Italy, and early in the following year besieged Naples. During the investment of the city a very severe disease, characterized by ulcers of the genitals, violent pains in the head and limbs, and generalized cutaneous eruptions broke out among the besiegers and spread rapidly throughout the army and civil population. On the return of the army to France, after the termination of the war, the disease rapidly spread throughout Europe, and the literature of the early part of the sixteenth century, both medical and lay, teems with references to it.

From the locality and other circumstances connected with its epidemic appearance the disease acquired various names. Thus, the French called it *morbus Neapolitanus*, or *mal d'Italie*, while the Italians termed it *morbus Gallicus*, or *mala Franzos*. At a very early period it was, however, clearly recognized that the disease was communicated during sexual intercourse, and

hence it was usually described in medical writings under the name *lues venerea*, while in the popular literature it still figured as the Frenchman's disease (*morbus Gallicus*). The name *syphilis* was first used in a poem descriptive of the disease, written in 1521 by Fracastor, a physician of Verona.

The extraordinary outbreak of the disease toward the end of the fifteenth century led to many speculations concerning its origin. As it attacked persons in all ranks and conditions of life, "sparing neither crown nor cross," in the words of a contemporary poet, the favorite explanation was that meteorological influences had much to do with its causation. Many ascribed it to the malign influence of the stars. The Neapolitans attributed it to the wickedness of their enemies, the French, while the latter laid the blame on the filth and immorality of the Italians. The Spaniards claimed that it had been imported from America by Columbus, whose first expedition returned to Europe in 1493. There are records, however, which prove that the disease already existed in Italy in the latter year. In other parts of Europe the Jews, who had been driven out of Spain by the terrors of the Inquisition, were accused of this, as of many other misfortunes which befell the people. When it was definitely established that the disease was communicated almost solely by sexual intercourse, the theory of its transatlantic origin became very popular. It is characteristic of human nature to refer the origin of troubles resulting from its own vices to some other source, if possible. This theory of the American origin of syphilis is still held by some writers. Within a few years, Dr. Joseph Jones, of New Orleans, claims to have found evidences of syphilitic disease in the skulls and other bones from some of the prehistoric Indian mounds in Mississippi. These observations of Dr. Jones have, however, not yet been verified by others.

Although the first great epidemic of syphilis is clearly traceable to the period between the years 1493 and 1496, an examination of the older literature reveals many descriptions of disease which can only be explained by assuming them to refer

to syphilis. The Old Testament Scriptures contain numerous references to diseases of the genital organs. In most instances these troubles are ascribed to the wrath of God, although in some cases a pretty shrewd hint is given as to the causation of the affections. Finály[1] remarks that the Hebrew word translated in all versions of the Bible by "flesh" signifies also the virile member. In this light, the references in Leviticus, XIII–XV; Numbers, XXV, 1–9, XXXI, 16–18; Deuteronomy, IV, 3; Joshua, XXII, 17; I Samuel, V, 6, 9, 12; Psalms, CVI, 28–30; I Corinthians, X, 8; Ephesians, II, 11; and Colossians, II, 13, receive a new interpretation. Numerous innuendoes in the Latin classics, and more or less exact descriptions in the medical writings of Greece, Rome, China, and India, leave no room for doubt that venereal diseases, and probably among them syphilis, have existed from the earliest times.

At the present day syphilis is the most widely prevalent of all contagious diseases. In 1873 Dr. F. R. Sturgis estimated that in New York 1 person out of every 18 suffered from it. This is considered a moderate estimate. Dr. J. Wm. White, of Philadelphia, pronounces the opinion that "not less than 50,000 people of all classes in that city are affected with syphilis." On this basis Gihon estimates the number of syphilitics in the United States at one time at 2,000,000.[2]

The disease is transmitted, in the vast majority of cases, during the performance of the sexual act, but there are numerous other ways in which it may be and frequently is communicated. In the special literature of the subject are records of many cases in which the disease was acquired through a kiss, a bite, the act of suckling (from infant to nurse, and conversely), using a pipe, glass-blowers' mouth-piece, the finger of a midwife, the instruments of the dentist or surgeon, inoculation of syphilitic secretion mixed with saliva in the process of tattooing, and many other ways. Numerous cases have been reported where physicians were inoculated on the finger while examining a syphilitic patient.

[1] Arch. f. Dermat. u. Syphilis, II Jahrg. 1 Heft., p. 126.
[2] The Prevention of Venereal Diseases by Legislation, Sanitarian, June, 1882.

The prophylactic measures which suggest themselves from a consideration of the nature of the disease are isolation of those infected, regular inspection of the class of persons through whom the disease is most frequently transmitted, *i.e.*, prostitutes, and individual precautions against acquiring it. Greater attention to cleanliness of the genital organs on the part of those indulging in promiscuous intercourse would aid largely in reducing the number of cases of syphilis.

DISEASES OF ANIMALS COMMUNICABLE TO MAN.

Sheep-pock.—This is a highly contagious and infectious disease of sheep, resembling, in its symptoms, course, and fatality, small-pox as it occurs in the human race. It is believed by Bollinger to be different from the form of small-pox produced in sheep, goats, horses, and other animals by the inoculation of human small-pox. Sheep-pock can be inoculated upon other animals and man, but only produces a local disease at the point of inoculation in the latter. Sheep may be protected against this disease by inoculation with sheep-pock virus (ovination), or by vaccination with vaccine lymph. The peculiarity of sheep vaccinia is that it is a more or less generalized disease, the pustules being distributed over the body. Sheep-pock, when inoculated upon human beings, does not produce a generalized infectious disease, but remains entirely local.

Actinomycosis.—Veterinarians have frequently observed a disease attacking the jaws of cattle and producing tumors, often with ulcerated surfaces. The bone is usually involved. The disease has heretofore been generally considered a sarcomatous growth. It is not seldom observed among the cattle in the western stockyards, where it is known in the vernacular as "swell-head." Recent investigations by Ponfick have shown that the growth consists of a vegetable parasite (actinomyces), and that it is inoculable upon other animals, and may be conveyed to man. A considerable number of cases have been observed in human beings in Germany, where the disease was

first described by Ponfick; and very recently 4 cases have been reported in this country.[1]

Bovine Tuberculosis (Perlsucht).—In cattle, tuberculosis occurs in two forms, miliary tubercles and cheesy masses in the lungs, and firm, pearly nodules on the serous membranes. These nodules do not break down, but may become calcified.

Bovine tuberculosis is a frequent disease among cows kept in damp, dark, and ill-ventilated stables. The disease, which is essentially the same as human tuberculosis, tubercle bacilli being present in the neoplasms, is believed by many to be transmissible to human beings by means of the milk or flesh of tuberculous animals. The sale of the meat of tuberculous cattle should be prohibited.

Rabies.—Hydrophobia in the brute, and its communicability to man through a bite, has been known from the remotest antiquity. It occurs in dogs, foxes, wolves, horses, and other animals, and may be transmitted from any of them to human beings.

The contagium of rabies, the infective poison, is contained principally in the saliva, and is usually inoculated by the teeth of the mad animal.

Pasteur has shown that the greatest virulence of the rabies poison resides in the brain and spinal cord of the animal suffering from the disease. By cultivation of this virus, the nature of which has not yet been definitely determined, its virulence could be diminished, and by inoculation of men and animals with the attenuated virus protection against the disease could be secured. The fact seems likewise established that the period of incubation of the inoculation-rabies is much shorter than that acquired in the usual way by bites of rabid animals. Hence, inoculation with the attenuated virus protects the bitten individual against the fatal outbreak of the unmodified disease.

Anthrax.—Anthrax, or splenic fever (milzbrand), is an

[1] Boston Med. and Surg. Journal, Oct. 16, 1884, p. 377, and Journ. Am. Med. Ass'n, Nov. 27, 1886. Also, N. E. Med. Monthly, Sept. 15, 1886.

acute, highly contagious and infectious disease of herbivorous animals, which may be transmitted by inoculation or the ingestion of the virus to other animals and to man.

The disease is due to a minute vegetable organism which is found in the blood and tissues of the diseased animals. This organism, *bacillus anthracis*, was first discovered by Pollender, and has been thoroughly investigated by Davaine, Pasteur, Koch, and others.

Inoculation of these bacilli or their spores always produces the disease in susceptible animals. Skins of animals not infrequently contain the virus, which may then gain access to the blood of persons engaged in handling them. Knackers, butchers, wool-sorters, and other persons liable to come in contact with sick animals, or handling their flesh or hides, are subject to the infection, either by direct inoculation (through abrasions of the skin, etc.) or by inhalation of the spores of the bacillus. An intestinal form of anthrax in man, *mycosis intestinalis*, is sometimes produced by the consumption of meat of animals suffering, when killed, of splenic fever. Numerous instances have been reported. The diagnosis has been verified by discovering the bacillus of anthrax in the blood and various organs of the individuals attacked.

In view of the dangerous character of the disease, persons coming in contact with animals suffering from anthrax should be warned of their peril. In order to protect other animals in a herd, strict isolation of the infected, thorough disinfection of the stables occupied by them, and deep interment of the cadavers of those dead from the disease are indicated.

Glanders.—Glanders, or farcy, is a very fatal contagious disease of horses which may be communicated to other animals and to man. The cause of glanders has recently been discovered by Löffler to be a bacillus resembling the bacillus tuberculosis. Pure cultures of this bacillus were inoculated into animals, and followed by glanders in a number of the cases.

The infection in man may occur either upon the seat of

excoriations of the skin or mucous membranes, especially those of the nose, conjunctiva, and possibly by inhalation of infective particles floating in the air.

Animals with glanders should be promptly killed and their cadavers cremated or deeply buried. No part of the body of any animal dead with glanders should be allowed to be used. Infected stables should be thoroughly disinfected.

[The works of especial value to students who desire fuller information upon the subjects treated in this chapter are the following:—

Hirsch, Handbuch der Historisch-Geographischen Pathologie, 2te Aufl., Stuttgart, 1883.—Hæser, Geschichte der Epidemischen Krankheiten.—Hecker, The Black Death, translated by B. G. Babington.—Defoe, Journal of the Plague in London.—Rohlfs, Die Orientalische Pest.—Marson, Small-pox, in Reynolds's System of Medicine, vol. i.—Seaton, Vaccination, *ibid.*—Trousseau, Clinical Medicine, vol. i.—Fifth Annual Report Illinois State Board of Health.—Hardaway, Essentials of Vaccination.—Crookshank, History and Pathology of Vaccination.—Woodworth and McClellan, Cholera Epidemic in United States in 1873.—Chaillé, Report of Yellow Fever Commission, Annual Report National Board of Health for 1880.—Wood and Formad, Memoir on the Nature of Diphtheria, *ibid.*, 1882.—Thompson, Annals of Influenza.—Stillé, Epidemic Meningitis.—Mueller, Die Venerischen Krankheiten im Altherthum.—Lancereaux, Traité de la Syphilis.—Bollinger, Ueber Menschen u. Thierpocken, etc., Samml. Klin. Vortr., No. 116.—Ponfick, Die Actinomycose des Menschen.—Gamgee, Hydrophobia and Glanders, in Reynolds's System of Medicine, vol. i.—Bollinger, Anthrax, in Ziemssen's Cyclopædia, vol. iii.]

CHAPTER XX.

Antiseptics, Disinfectants, and Deodorants.

Much confusion exists in the popular mind, and even among physicians, as to the exact meaning of the terms at the head of this chapter. By many they are used synonymously, and hence frequently give rise to ambiguity and misunderstanding.

Antisepsis, which is so frequently confounded with disinfection, should be more accurately defined than is usual by writers. An antiseptic is an agent which retards, prevents, or arrests putrefaction, decay, or fermentation. It does not necessarily destroy the vitality of the organisms upon which these processes depend. An antiseptic may also arrest the development of the organisms which cause infectious diseases, and may hence be used as a preventive of such diseases. But antiseptics do not destroy the life of disease-germs, and hence cannot be relied upon when such organisms are present.

By disinfection, in the proper and restricted use of the term, is meant the destruction of the specific infectious material which causes infectious diseases. If the view is accepted that all infectious diseases are due to micro-organisms or germs, then a disinfectant is equivalent to a germicide. In sanitary practice and experimental investigations this view is, in fact, adopted. In testing the action of various disinfecting agents upon infectious material, the biological test is the one universally relied upon by experimenters, and no observations upon disinfection based upon chemical tests alone would be accepted by sanitarians as conclusive. It may therefore be assumed for practical purposes that no agent can be accepted as a disinfectant if it is not also a germicide. From this it follows that disinfection, to be trustworthy, must be thorough. "There can be no partial disinfection of infectious material; either its infectious power is destroyed, or it is not. In the latter case there is a failure to disinfect."[1] Obviously, also, there can be no disinfection in the

[1] Report of Committee on Disinfectants of the American Public Health Association, p. 236.

absence of infectious material. Fæcal discharges, a diseased body or corpse, clothing, bedding, an apartment, a ship, or a hospital ward may or may not be infected. In the former case we may speak of disinfecting them; in the latter, it would be an inappropriate use of the word.

Confusion is also liable to arise by considering disinfectants and deodorizers as synonymous. Deodorants merely remove offensive odors, and may not possess any disinfecting power whatever. Thus, one of the most efficient disinfectants at our command (mercuric chloride) is not a deodorizer at all, except by preventing putrefaction. On the other hand, some of the most effective deodorants have only a subordinate position in the scale of disinfectants.

Careful investigations have shown that there is a wide divergence between various disinfecting agents in their influence upon disease-germs, some being efficient in high dilutions, while others require to be brought in contact with the germs in great concentration. For example, mercuric chloride will act as an efficient poison to certain disease-germs (anthrax spores) in the proportion of 1 to 1000, while zinc-chloride must be used in the proportion of 1 to 5 (or 20 per cent.).

It has been, further, discovered that different disease-germs present varying resisting power to the same disinfecting agent, some being easily destroyed, while others are much more resistant. For example, the following table shows a number of experiments made by Dr. Meade Bolton for the American Committee on Disinfectants:—

TABLE XXVII.

ORGANISM.	Chloride of Lime.	Mercuric Chloride.	Carbolic Acid.
Typhoid bacillus	1:2000	1:10,000	1:100
Cholera spirillum	1:2000	1:10,000	1:100
Anthrax spores	1:100	1:1000	1:50 (Uncertain.)
Staphylococcus aureus . . .	1:200	. . . . .	1:100
Staphylococcus citreus . .	1:50	. . . . .	1:100
Staphylococcus albus . . .	1:200	. . . . .	1:100

Assuming that infectious diseases are caused by micro-organisms, and that these are different from the micro-organisms of ordinary decay or putrefaction, it can be readily understood that the processes of organic decomposition may themselves act as disinfectants. It is known, for example, that when a fermenting liquid putrefies, the organisms of fermentation disappear and give place to the organisms of putrefaction (bacterium termo, etc.). So, likewise, the bacilli of anthrax and of tuberculosis are killed by the putrefactive process, if this takes place in the absence of free oxygen. Furthermore, the reproduction of organisms of a certain kind ceases when certain chemical (?) changes take place in their environment. Fermentation in a saccharine liquid ceases and the ferment-organisms die when the accumulation of the product of the fermentation (alcohol) has reached a certain proportion, although there may still be undecomposed sugar present. In like manner it is intelligible that the products of micro-organisms may eventually destroy their producers, and so place a limit to the morbid process. The specific cause of small-pox, yellow fever, cholera, and similar infectious diseases is rapidly destroyed when decomposition of the corpses of those dead with such diseases sets in. Hence, the reason why infectious diseases are not spread from cemeteries.

From the foregoing it may be gathered that disinfection consists chiefly in a struggle against organized disease-germs.[1] As, however, experiments and observations have shown that the life-history of disease-germs varies with the different organisms involved, it becomes evident that specific directions concerning disinfection can be given only when the life-history of the specific organism is known.

The American Committee on Disinfectants, to whose work reference has already been made, divides disinfectants into two classes: those efficient for the destruction of infectious material containing spores, and those which will destroy infectious material only in the absence of spores. The recommendations of

[1] Mueller und Falk, in Realencyclopædie d. ges. Heilk., Bd. IV., p. 62.

the committee, covering not only the appropriate disinfectant to be used for the destruction of the organisms, but also the conditions under which the agent should be used, are as follow:—

The most useful agents for the destruction of spore-containing infectious material are:—

1. *Fire.* Complete destruction by burning.
2. *Steam under pressure.* 105° C. (221° F.) for ten minutes.
3. *Boiling in water* for half an hour.
4. *Chlorinated lime.*[1] A 4-per-cent. solution.
5. *Mercuric chloride.* A solution of 1 to 500.

For the destruction of infectious material which owes its infecting power to the presence of micro-organisms not containing spores, the committee recommends:—

1. *Fire.* Complete destruction by burning.
2. *Boiling in water* for ten minutes.
3. *Dry heat.* 110° C. (230° F.) for two hours.
4. *Chlorinated lime.*[1] A 2-per-cent. solution.
5. *Solution of chlorinated soda.*[2] A 10-per-cent. solution.
6. *Mercuric chloride.* A solution of 1 to 2000.
7. *Sulphur dioxide.* Exposure for twelve hours to an atmosphere containing at least 4 volumes per cent. of this gas in presence of moisture.[3]
8. *Carbolic acid.* A 5-per-cent. solution.
9. *Sulphate of copper.* A 5-per-cent. solution.
10. *Chloride of zinc.* A 10-per-cent. solution.

The committee would make the following recommendations with reference to the practical application of these agents for disinfecting purposes:—

FOR EXCRETA.

(*a*) In the sick-room:—

1. Chlorinated lime in solution, 4 per cent.

In the absence of spores:—

2. Carbolic acid in solution, 5 per cent.
3. Sulphate of copper in solution, 5 per cent.

(*b*) In privy-vaults:—

1. Mercuric chloride in solution, 1 to 500.[4]
2. Carbolic acid in solution, 5 per cent.

[1] Should contain at least 25 per cent. of available chlorine.

[2] Should contain at least 3 per cent. of available chlorine.

[3] This will require the combustion of between 1½ to 2 kilogrammes of sulphur for every 28 cubic metres of air-space.

[4] The addition of an equal quantity of potassium permanganate as a deodorant, and to give color to the solution, is to be recommended.

(*c*) For the disinfection and deodorization of the surface of masses of organic material in privy-vaults etc.:—

Chlorinated lime in powder.

For Clothing, Bedding, etc.

(*a*) Soiled underclothing, bed-linen, etc.:—

1. Destruction by fire, if of little value.
2. Boiling for at least half an hour.
3. Immersion in a solution of mercuric chloride of the strength of 1 to 2000 for four hours.
4. Immersion in a 2-per-cent. solution of carbolic acid for four hours.

(*b*) Outer garments of wool or silk, and similar articles, which would be injured by immersion in boiling water or in a disinfecting solution:—

1. Exposure in a suitable apparatus to a current of steam for ten minutes.
2. Exposure to dry heat at a temperature of 110° C. (230° F.) for two hours.

(*c*) Mattresses and blankets soiled by the discharges of the sick:—

1. Destruction by fire.
2. Exposure to superheated steam (105° C. = 221° F.) for ten minutes. (Mattresses to have the cover removed or freely opened.)
3. Immersion in boiling water for half an hour.

Furniture and Articles of Wood, Leather, and Porcelain.

Washing, several times repeated, with solution of carbolic acid, 2 per cent.

For the Person.

The hands and general surface of the body of attendants of the sick, and of the convalescents, should be washed with—

1. Solution of chlorinated soda diluted with nine parts of water (1 to 10).
2. Carbolic acid, 2-per-cent. solution.
3. Mercuric chloride, 1 to 1000.

For the Dead.

Envelop the body in a sheet thoroughly saturated with—

1. Chlorinated lime in solution, 4 per cent.
2. Mercuric chloride in solution, 1 to 500.
3. Carbolic acid in solution, 5 per cent.

For the Sick-room and Hospital Wards.

(*a*) While occupied, wash all surfaces with—

1. Mercuric chloride in solution, 1 to 1000.
2. Carbolic acid in solution, 2 per cent.

(*b*) When vacated:—

Fumigate with sulphur dioxide for twelve hours, burning at least 1½ kilogrammes sulphur for every 28 cubic metres of air-space in the room; then wash all surfaces with one of the above-mentioned disinfecting solutions, and afterward with soap and hot water; finally throw open doors and windows and ventilate freely.

For Merchandise and the Mails.

The disinfection of merchandise and of the mails will only be required under exceptional circumstances; free aëration will usually be sufficient. If disinfection seems necessary, fumigation with sulphur dioxide will be the only practicable method of accomplishing it without injury.

Rags.

(*a*) Rags which have been used for wiping away infectious discharges should at once be burned.

(*b*) Rags collected for the paper-makers during the prevalence of an epidemic should be disinfected, before they are compressed in bales, by—

1. Exposure to superheated steam (105° C. = 221° F.) for ten minutes.
2. Immersion in boiling water for half an hour.

Ships.

(*a*) Infected ships at sea should be washed in every accessible place, and especially localities occupied by the sick, with—

1. Solution of mercuric chloride, 1 to 1000.
2. Solution of carbolic acid, 2 per cent.

The bilge should be disinfected by the liberal use of a strong solution of mercuric chloride.

(*b*) Upon arrival at a quarantine station, an infected ship should at once be fumigated with sulphurous-acid gas, using 1½ kilogrammes of sulphur for every 28 cubic metres of air-space; the cargo should then be discharged on lighters; a liberal supply of the concentrated solution of mercuric chloride (1 to 32) should be thrown into the bilge, and at the end of twenty-four hours the bilge-water should be pumped out and replaced with pure sea-water; this should be repeated. A second fumigation after the removal of the cargo is recommended. All accessible

surfaces should be washed with one of the disinfecting solutions heretofore recommended, and subsequently with soap and hot water.

For Railway-cars.

The directions given for the disinfection of dwellings, hospital wards, and ships apply as well to infected railway-cars. The treatment of excreta with a disinfectant before they are scattered along the tracks seems desirable at all times, in view of the fact that they may contain infectious germs. During the prevalence of an epidemic of cholera this is imperative. For this purpose the standard solution of chlorinated lime is recommended.

From the foregoing it would appear that heat, chlorinated lime, mercuric chloride, solution of chlorinated soda (Labarraque's solution), carbolic acid, sulphate of copper, zinc chloride, and sulphur dioxide (sulphur-fumes) are the most generally available disinfectants.

The following "general directions" for the practical application of disinfection are given by the committee:—

Disinfection of Excreta, etc.—The infectious character of the dejections of patients suffering from cholera and typhoid fever is well established; and this is true of mild cases and of the earliest stages of these diseases, as well as of severe and fatal cases. It is probable that epidemic dysentery, tuberculosis, and perhaps diphtheria, yellow fever, scarlet fever, and typhus fever may also be transmitted by means of the alvine discharges of the sick. It is, therefore, of the first importance that these should be disinfected. In cholera, diphtheria, yellow fever, and scarlet fever all vomited material should also be looked upon as infectious. And in tuberculosis, diphtheria, scarlet fever, and infectious pneumonia the sputa of the sick should be disinfected or destroyed by fire. It seems advisable, also, to treat the urine of patients sick with an infectious disease with one of the disinfecting solutions below recommended.

Chloride of lime, or bleaching powder, is perhaps entitled to the first place for disinfecting excreta, on account of the rapidity of its action. The following standard solution is recommended:—

Dissolve chloride of lime (chlorinated lime, bleaching powder) of the best quality[1] *in pure water in the proportion of 6 ounces to the gallon (45 grammes to the litre).*

Use 1 quart (1 litre) of this solution for the disinfection of each discharge in cholera, typhoid fever, etc.[2] Mix well, and leave in the vessel

[1] Good chloride of lime should contain at least 25 per cent. of available chlorine.

[2] For a very copious discharge use a larger quantity.

for at least one hour before throwing into privy-well or water-closet. The same directions apply for the disinfection of vomited matters. Infected sputum should be discharged directly into a cup half full of the solution.[1] A 5-per-cent. solution of carbolic acid may be used instead of the chloride-of-lime solution, the time of exposure to the action of the disinfectant being four hours.

Disinfection of the Person.—The surface of the body of a sick person or of his attendants, when soiled with infectious discharges, should be at once cleansed with a suitable disinfecting agent. For this purpose, solution of chlorinated soda (liquor sodæ chlorinatæ—Labarraque's solution) diluted with 9 parts of water, or the standard solution of chloride of lime diluted with 3 parts of water, may be used. A 2-per-cent. solution of carbolic acid is also suitable for this purpose, and under proper medical supervision the use of a solution of corrosive sublimate (1 to 1000) is to be recommended.

In diseases like small-pox and scarlet fever, in which the infectious agent is given off from the entire surface of the body, occasional ablutions with the above-mentioned solution of chlorinated soda are recommended.

In all infectious diseases the body of the dead should be enveloped in a sheet saturated with the standard solution of chlorinated lime, or with a 5-per-cent. solution of carbolic acid, or a 1 to 500 solution of corrosive sublimate.

Disinfection of Clothing.—Boiling for half an hour will destroy the vitality of all known disease-germs, and there is no better way of disinfecting clothing or bedding which can be washed than to put it through the ordinary operations of the laundry. No delay should occur, however, between the time of removing soiled clothing from the person or bed of the sick and its immersion in boiling water, or in one of the following solutions until this can be done:—

Corrosive sublimate, 1 gramme to the litre (1 to 1000), or carbolic acid (pure), 8 grammes to the litre.

The articles to be disinfected must be thoroughly soaked with the disinfecting solution and left in it for at least two hours, after which they may be wrung out and sent to the wash.[2]

Clothing or bedding which cannot be washed should be disinfected

[1] Recently a small spitting-cup made of stiff paper has been introduced especially for the use of consumptives. The cup is carried about by the patient or kept within reach. When the cup has been in use for a time, and before the sputa can become desiccated, it is thrown into the fire and burned.

[2] Solutions of corrosive sublimate should not be placed in metal receptacles, for the salt is decomposed and the mercury precipitated by contact with copper, lead, or tin. A wooden tub or earthen crock is a suitable receptacle for such solutions.

by steam in a properly-constructed disinfection chamber. In the absence of a suitable steam disinfecting apparatus, infected clothing and bedding should be burned.

Disinfection of the Sick-room.—In the sick-room no disinfectant can take the place of free ventilation and cleanliness. It is an axiom in sanitary science that it is impracticable to disinfect an occupied apartment for the reason that disease-germs are not destroyed by the presence in the atmosphere of any known disinfectant in respirable quantity. Bad odors may be neutralized, but this does not constitute disinfection in the sense in which the term is here used. These bad odors are, for the most part, an indication of want of cleanliness or of proper ventilation, and it is better to turn contaminated air out of the window or up the chimney than to attempt to purify it by the use of volatile chemical agents, such as carbolic acid, chlorine, etc., which are all more or less offensive to the sick, and are useless so far as disinfection—properly so called—is concerned.

When an apartment which has been occupied by a person sick with an infectious disease has been vacated, it should be disinfected. The object of disinfection in the sick-room is mainly the destruction of infectious material attached to surfaces or deposited as dust upon window-ledges, in crevices, etc. If the room has been properly cleansed and ventilated while still occupied by the sick person, and especially if it was stripped of carpets and unnecessary furniture at the outset of his attack, the difficulties of disinfection will be greatly reduced.

All surfaces should be thoroughly washed with the standard solution of chloride of lime, diluted with 3 parts of water, or with 1 to 1000 solution of corrosive sublimate. The walls and ceiling, if plastered, should be subsequently treated with a lime-wash. Especial care must be taken to wash away all dust from window-ledges and other places where it may have settled, and thoroughly to cleanse crevices and out-of-the-way places. After this application of the disinfecting solution, and an interval of twenty-four hours or longer for free ventilation, the floors and wood-work should be well scrubbed with soap and hot water, and this should be followed by a second, more prolonged exposure to fresh air, admitted through open doors and windows.

As an additional precaution, fumigation with sulphurous-acid gas is to be recommended, especially for rooms which have been occupied by patients with small-pox, scarlet fever, diphtheria, typhus fever and yellow fever. But fumigation with sulphurous-acid gas alone, as commonly practiced, cannot be relied upon for disinfection of the sick-room and its contents, including bedding, furniture, infected clothing, etc., as is popularly believed.

When fumigation is practiced, it should precede the general washing with a disinfecting solution heretofore recommended. To insure any results of value, it will be necessary to close the apartment to be disinfected as completely as possible by stopping up all apertures through which the gas might escape, and to burn not less than 3 pounds of sulphur for each 1000 cubic feet (1½ kilogrammes to 28 cubic metres) of air-space in the room. To secure complete combustion of the sulphur, it should be placed, in the form of powder or small fragments, into a shallow iron pan, which should be set upon a couple of bricks in a tub partly filled with water, to guard against fire. The sulphur should be thoroughly moistened with alcohol before igniting it.

Disinfection of Privy-vaults, Cess-pools, etc.—When the excreta (not previously disinfected) of patients with cholera or typhoid fever have been thrown into a privy-vault this is infected, and disinfection should be resorted to as soon as the fact is discovered, or whenever there is reasonable suspicion that such is the case. It will be advisable to take the same precautions with reference to privy-vaults into which the excreta of yellow fever have been thrown, although we do not definitely know that this is infectious material.

For this purpose the standard solution of chloride of lime may be used in quantity proportioned to the amount of material to be disinfected, but where this is considerable it will scarcely be practicable to sterilize the whole mass. The liberal and repeated use of this solution, or of a 5-per-cent. solution of carbolic acid, will, however, disinfect the surface of the mass, and is especially to be recommended during the epidemic prevalence of typhoid fever or of cholera.

All exposed portions of the vault, and the wood-work above it, should be thoroughly washed down with the disinfecting solution. Instead of the disinfecting solutions recommended, chloride of lime in powder may be daily scattered over the contents of the privy-vault.

Disinfection of Ingesta.—It is well established that cholera and typhoid fever are very frequently, and perhaps, usually, transmitted through the medium of infected water or articles of food, and especially milk. Fortunately, we have a simple means at hand for disinfecting such infected fluid. This consists in the application of heat. The boiling temperature maintained for half an hour kills all known disease-germs. So far as the germs of cholera, yellow fever, and diphtheria are concerned, there is good reason to believe that a temperature considerably below the boiling-point of water will destroy them. But in order to keep on the safe side, it is best not to trust anything short of the boiling-point (100° C. = 212° F.) when the object is to disinfect food or drink which is open to the suspicion of containing the germs of any infectious disease.

During the prevalence of an epidemic of cholera it is well to boil all water for drinking purposes. After boiling, the water may be filtered, if necessary, to remove sediment, and then cooled with *pure ice* if desired.

The following substances are antiseptics, but in the strength given cannot be depended upon as disinfectants:—

TABLE XXVIII.

Thymol,	1:80,000.
Bichloride of mercury,	1:40,000.
Oil of mustard,	1:33,000.
Acetate of alumina,	1:6310.
Bromine,	1:5597.
Picric acid,	1:5000.
Iodine,	1:4000.
Sulphuric acid,	1:800–1:3353.
Permanganate of potassium,	1:3000.
Camphor,	1:2500.
Eucalyptol,	1:2500.
Chromic acid,	1:2200.
Chloride of aluminum,	1:2000.
Hydrochloric acid,	1:1700.
Benzoic acid,	1:1439.
Quinine,	1:1000.
Boric acid,	1:200–1:800.
Salicylic acid,	1:200–1:800.
Carbolic acid,	1:500.
Sulphate of copper,	1:400.
Nitric acid,	1:400.
Biborate of soda,	1:200.
Sulphate of iron,	1:200.
Creasote,	1:200.
Arsenious acid,	1:100.
Pyrogallic acid,	1:62.
Tr. chloride of iron,	1:25.
Alcohol,	40 to 95 per cent.

The agents mentioned in the above list may all be used with satisfactory results in surgical and obstetrical practice as antiseptics, but it must be borne in mind that the great danger in treating wounds comes from carrying infectious particles to them in the hands or instruments of the operator. In order to

render these aseptic the most thorough measures of disinfection, such as heat, strong chemical disinfectants, and physical as well as chemical and biological cleanliness are indicated. In a surgical wound, or in the vagina and uterus of the parturient woman, the use of antiseptics is entirely secondary to disinfection, under which may primarily be understood rigid cleanliness.

In public and private sanitation, antiseptics have, as in practical surgery, a subordinate importance.

Deodorizers are sometimes useful in sanitary practice, but care must be taken not to look upon deodorization as equivalent to disinfection. Among the most useful deodorizers are chloride of zinc, chloride of lime, permanganate of potassium, and a number of the agents mentioned in Table XXVIII.

[The following additional works are recommended for study in connection with this chapter:—

Sternberg and Magnin, The Bacteria, 2d ed.—Fluegge, Fermente und Mikroparasiten, in von Pettenkofer und Ziemssen's Handb. d. Hygiene, I Th., 2 Abth., 1 Hft.—Wernich, Desinfectionslehre zum praktischen Gebrauch.—Vallin, Traité des Désinfectants et de la Désinfection. —Final Report of the Committee on Disinfectants of the American Public Health Association.—Sternberg, Disinfection and Personal Prophylaxis Lomb Prize Essay. 1886.]

CHAPTER XXI.

Vital Statistics.

The registration of vital statistics comprises the recording of the births, marriages, deaths, and diseases of a city, State, or nation. In no other way can a knowledge of the health of the inhabitants of such communities be obtained. For smaller, or special communities, such as armies, navies, schools, or special classes of workmen, the health status may be ascertained by direct methods; but for larger communities this is clearly impracticable, and the sanitarian is obliged to depend upon the census and the registration of births, marriages, and deaths.

From a sanitary point of view, the most important object of a registration of vital statistics is to "give warning of the undue increase of disease or death presumed to be due to preventable causes, and also to indicate the localities in which sanitary effort is most desirable and most likely to be of use."[1]

The duty of registration should devolve upon the sanitary administration. Local and State boards of health would seem to be the most appropriate media for collecting information bearing upon births, diseases, and deaths. It would seem also to be most appropriate to require the attending physicians to make reports of deaths and of cases of contagious diseases to the health authorities.

REGISTRATION OF DEATHS.

The data entered upon the record of death should comprise the name, age, sex, color, nativity, descent, occupation, and civil condition of decedent, with date, place, and cause of death. Under the heading "Descent," the birthplace of each parent should be given. Occupation should be accurately

[1] J. S. Billings, Registration of Vital Statistics, Am. Jour Med. Sciences, vol. lxxxv, p. 37.

specified. The place of death should indicate the exact locality (number of street) where it occurred. Both proximate and predisposing causes of death should be entered, and any complications which may have influenced the fatal termination should be noted on the record.

This record should be in the possession of the local health authority before a permit for the burial of the deceased is granted. If this is not insisted upon, the report will soon be omitted and the registration become defective.

REGISTRATION OF BIRTHS.

The collection of data for an accurate registration of births is much more difficult than the record of deaths. Instead of requiring physicians and midwives in attendance at the confinement to report births, it would be more equitable and probably more effectual to compel the parents, under a penalty for failure, to record the birth of each child at the board of health. The items usually included in birth returns are: date and place of birth, sex and color of child, names of father and mother, parents' nativity and age, and father's occupation. Sometimes the residence of the mother, number of children previously borne by the same mother, whether the child is legitimate or not, and various other details are also added. It is evident that for sanitary purposes most of this information is entirely irrelevant. It seems to the author that, for the purpose of the sanitarian and medical statistician, the date and place of birth, sex and color of the child, and age, nativity, and occupation of both parents are sufficient.

REGISTRATION OF MARRIAGES.

The record of marriages is of no interest to the sanitarian. If, however, the registration could be made by a competent medical man, and the physical condition of the contracting parties noted, valuable deductions might be made in time, especially if the parties themselves and their offspring could be kept under

observation for many years. This, however, is so manifestly impracticable that it barely deserves notice in this place.

REGISTRATION OF DISEASES.

As has been seen in Chapter XIX, a large class of diseases are communicable from one individual to another, either directly, by contact, or mediately, by infection. In large communities it is therefore important that the sanitary authorities should possess information of the presence and prevalence of these diseases, in order that measures may be instituted for their restriction. It is true that in most cases the registration of deaths gives but too mournful evidence of the more fatal of the diseases of this class, but destructive epidemics could probably be frequently averted if preventive measures could be enforced early. Besides, in the case of dengue and epidemic influenza, the death-rate is so small that, if the registration of deaths were alone depended upon, no evidence whatever might be attainable of the epidemic prevalence of such diseases.

The registration of prevailing diseases is, therefore, one of the most important duties of the registrar of vital statistics. Prompt notice of all cases of infectious, miasmatic, or contagious diseases coming under their professional notice should be required of all physicians. It is unquestionably just, however, that the physicians required to perform this duty should be properly compensated by the public, whose interests they serve.

DEATH-RATE AND BIRTH-RATE.

In order to calculate the annual death-rate of a place, two facts are required to be known: first, the actual or estimated population (generally obtained from the census), and, second, the number of persons who died within the district. The number of deaths is then divided by the population, which gives the death-rate for each individual for the year. To find the death-rate per 1000, the death-rate as found above is multiplied by 1000. Thus, the total number of deaths in the city of Baltimore

during 1883 was 9380, and the estimated population 408,520. The death-rate for the year was 22.96 per 1000, obtained as follows:—

$$\frac{9380 \times 1000}{408{,}520} = 22.96 \text{ per M.}$$

To calculate the annual death-rate of a place for each 1000 of the population from the returns for one week, the weekly population for the place is first ascertained, and then the total number of deaths for the week divided by the weekly population, and the quotient multiplied by 1000. The following concrete example will render this clear:—

The exact number of weeks in a year is 52.17747. The total population is divided by this figure, giving the weekly population. This gives for Baltimore, assuming the above estimate to be correct, a weekly population of 7829. For the week ending November 1, 1884, the deaths in that city numbered 148. The annual death-rate per 1000—that is to say, the number of deaths in each 1000 of population, if the same ratio were maintained throughout the year—is obtained as follows:—

$$\frac{148 \times 1000}{7829} = 18.9 \text{ per M per annum.}$$

Out of the above 148 deaths, 32 were from infectious diseases. To find the annual death-rate per 1000 of population for this class of diseases, the same calculation is made, thus:—

$$\frac{32 \times 1000}{7829} = 4.1 \text{ per M per annum.}$$

Or, if the percentage of deaths of infectious diseases be desired, the procedure would be as follows:—

$$\frac{32 \times 100}{148} = 21.6 \text{ per cent. of the total deaths.}$$

Sixty-four of the decedents were under 5 years of age. The death-rate for this class is found in the same manner; for example:—

$$\frac{64 \times 1000}{7829} = 8.17 \text{ per M per annum.}$$

Or the percentage of these to the total deaths is found as in the last example.

If it be desired to find the rate of infant mortality, *i.e.*, the proportion of deaths among infants under 1 year of age to the total number of births for the same period, the following formula may be used. In the record just quoted the decedents under 1 year of age numbered 37; the total number of births for the same week was 157. Hence—

$$\frac{37 \times 1000}{157} = 235.7 \text{ per } 1000 \text{ births},$$

or nearly 1 to 4.

Thirty-three of these 148 deaths were of colored persons. The death-rate of these to the total population is found in a similar manner to the above; but if it is desired to ascertain the death-rate of the colored population alone, the weekly colored population must first be obtained and the rate calculated from this by the above formula.

Birth-rates are found in a similar manner. The average age at death is ascertained by adding up the ages of all the decedents, and dividing the sum by the number of deaths.

It will be evident, on a little thought, that there must be many sources of error in calculations based upon such uncertain data as are derived from the registration of births and deaths as conducted in most cities in this country. Besides, the subject of vital statistics is essentially abstruse, and requires no little readiness in mathematics to appreciate its profounder bearings. Hence, in the foregoing chapter no attempt has been made to penetrate beyond the immediate practical aspects of the questions involved.

[To those desiring fuller information upon this subject, the following works are recommended:—

Curtis, Vital Statistics, in Buck's Hygiene and Public Health.—Billings, Registration of Vital Statistics, American Journal Medical Sciences, vol. lxxxv.—Oldendorff, Morbilitæts and Mortalitæts-Statistik, in Realencyclopædie d. ges. Heilk., Bd. IX.—Billings, Papers on Vital Statistics, Sanitary Engineer, vol. viii, ix.—*Ibid.*, Cartwright Lectures on Vital and Medical Statistics, 1890.]

CHAPTER XXII.

Quarantine.

(By Walter Wyman, M.D., Surgeon United States Marine-Hospital Service.)

By quarantine is meant the adoption of restrictive measures to prevent the introduction of diseases from one country or locality into another. The term itself conveys no definite idea, being derived through the Italian from the latin "quadraginta," meaning "forty" and implying forty days, the period of detention imposed on vessels by the first quarantines established at Venice in 1403. The old significance of the term is entirely lost in its present application, which is quite general. Thus, besides regular maritime quarantine, mention is often made of land, railroad, cattle, shot-gun, house, and even room quarantines.

The name of a disease or article of merchandise may be used in prefix, as in "yellow-fever quarantine," small-pox, cholera, or rag quarantine. Moreover, quarantines are described as properly beginning at the port of departure, and as quarantines of inspection only, the fumigation and detention being imposed at some neighboring station. The term, therefore, is applied not only to establishments, but indifferently to persons, animals, diseases, localities, and measures.

There is need of a clear understanding with regard to the term, for when, as occasionally, quarantine is ridiculed, or the assertion is made that the English disbelieve in quarantine, a wrong impression will be received, unless it is understood that only particular and obsolete forms of quarantine are meant, and not quarantine in the broad sense just mentioned.

The subject admits of two natural divisions—maritime and land quarantine; but before describing them attention is called to the following table, containing a list of diseases that are ordinarily found in official quarantine proclamations:—

QUARANTINABLE DISEASES.—TABLE XXIX.

DISEASE.	PERIOD OF INCUBATION, IN DAYS.			
	Shortest.	Longest.	Usual.	Authority and Remarks.
Plague	..	..	....	Bristow. Undetermined.
Yellow fever . . .	1	9	$2\frac{1}{2}$	Da Costa, Bartholow.
Cholera	2	14	2 to 4	Bartholow.
Typhus fever . . .	1	21	5 to 14	Bristow.
Small-pox	5	20	10	Da Costa.
Measles	7	14	10	Da Costa.
Diphtheria	2	10	2 to 5	Bartholow.
Typhoid fever . .	7	28	21	Bartholow.
Scarlet fever . . .	1	weeks.	4 to 7	Da Costa.
Relapsing fever . .	5	7	6	Bartholow.
Dengue	1	10	5	Bartholow.
Leprosy.	..	..	....	Undetermined.

The above list illustrates the growth of the sanitary idea and belief in quarantine. For many years, as now at some ports, the list was limited to yellow fever, typhus, cholera, and small-pox. It was thus limited at Boston prior to 1881, since which date diphtheria, scarlet fever, typhoid fever, and measles have been added. The statutes of New York define as quarantinable "yellow fever, measles, cholera, typhus or ship fever, small-pox, scarlatina, diphtheria, relapsing fever, and any disease of a contagious, infectious, or pestilential character, which shall be considered by the health officer dangerous to the public health."

At Gibraltar, the English sanitary authorities include dengue and epidemic rose-rash among the diseases subject to their quarantine regulations.

The most recent addition to the list in this country is leprosy, to prevent the introduction of which, and in accordance with a resolution of the American Public Health Association, a prohibitory circular was issued by the Surgeon-General of the Marine-Hospital Service, December 23, 1889.

Other diseases which may properly call for quarantine are mumps, whooping-cough, chicken-pox, epidemic dysentery,

glanders, tetanus, beriberi, epidemic influenza, and pulmonary tuberculosis.

Influenza may be considered quarantinable under certain circumstances, a successful quarantine being reported by Dr. Trudeau, whose cottage sanitarium, in the Adirondacks, New York, was thus kept exempt during the epidemic of 1890.

With regard to pulmonary tuberculosis the ground is taken by the writer that this disease, at least among immigrants, should be excluded from the United States by quarantine.

MARITIME QUARANTINE.

In describing a maritime quarantine it should be borne in mind that the details in the plant must vary in accordance with the special demands of each port.

Thus, it is not to be expected that at Charleston, where immigration is limited, there should be the same provisions for detention of immigrants as at New York, through whose portals more than one-third of a million of immigrants pass each year; or San Francisco, where enter the throng of travelers and immigrants from the far East.

We should not expect that Boston, in the more salubrious North, would have the means or adopt the practice of emptying, cleaning, and fumigating every vessel from an infected port, which process has proven to be the *sine qua non* of exemption to the State of Louisiana.

Nor should we expect Pensacola, with a completely-equipped national refuge-station near at hand (at Chandeleur Island), to erect an expensive disinfecting-house, with modern steam disinfecting-chambers, as has been recently done for the port of Galveston by the health authorities of Texas.

But, leaving these variations for subsequent notice, the first thing to be considered in the establishment of a complete maritime quarantine is proper location. This must be at a point remote from city or village boundaries, and not likely to be encroached upon by urban growth. It should be more or

less removed from the channels of commerce, and yet be easily accessible. Indifference to proper location could readily make the quarantine a source of danger instead of a protection. After proper location, the main requirements may be stated as follows:—

1. A boarding-station. This includes a boat-house with boatmen's quarters, so located as to avoid possible infection from the lazaretto and to be within easy reach of passing commerce.

2. A boarding-boat, preferably a steamer.

3. An anchorage. The anchorage is the place of detention of the infected vessel. It should be conveniently removed from the main establishment and safely remote from the track of commerce. Its position should be sheltered, and good holding-ground for vessels' anchors is of the first importance. The channel to the anchorage, and, if necessary, its boundaries, should be plainly marked by buoys.

4. A fumigation steamer, to be described under "Quarantine Contrivances."

5. A wharf. The wharf should be in water of at least 20 feet depth, and there should be constructed upon it a warehouse, tanks for holding disinfecting-solutions, and a disinfection-house containing steam disinfecting-chambers.

6. A lazaretto or hospital for treatment of contagious diseases.

7. A hospital for treatment of non-contagious diseases.

8. Barracks for the detention in groups of "suspects," or persons who have been exposed to contagion or infection.

9. Quarters for medical officers.

10. A cremation-furnace.

No better understanding of the subject can be had than by a brief survey of the several varieties of maritime quarantines that are now maintained on the coasts of the United States. First should be mentioned the national quarantine stations, eight in number, established at points of danger where either local quarantine is defective, or where, by reason of peculiar advan-

tage in location, protection is afforded to several States by one station. These stations are as follow:—

Delaware Breakwater Quarantine Station, Lewes, Del.; Cape Charles Quarantine Station, Fisherman's Island, Va.; South Atlantic Quarantine Station, Blackbeard Island, Sapelo Sound, Georgia; Key West Quarantine Station, Tortugas Islands, Fla.; Gulf Quarantine Station, Chandeleur Island, Miss.; San Diego Quarantine Station, San Diego, California; San Francisco Quarantine Station, Angel Island, San Francisco Bay, California; and Port Townsend Quarantine Station, Port Townsend, Washington.

Most of these stations will be complete in plant and equipment within a short time, but pending completion active quarantine is maintained the whole year through at all of them, San Francisco excepted,—there being a local quarantine at this port.

The estimated cost of the national quarantine station at Angel Island, San Francisco Bay, is $175,000, exclusive of the site, which was in previous possession of the government.

Surgeon-General Hamilton, in a recent report, says:—

"It is evident that a few complete stations of this kind will take the place of the many municipal quarantines. The latter will become, eventually, simply boarding-stations, and vessels requiring treatment will be sent to the nearest government quarantine station."

No fees are exacted at the national stations.

Many of the local quarantine establishments, while entirely effective for ordinary quarantine, the occasional detection and care of a few contagious cases, would prove insufficient and become, in fact, more dangerous than beneficial in the presence of a heavy inroad of an epidemic disease, such as the appearance of a ship with a thousand emigrants aboard, having a history of many deaths at sea from cholera, and cholera still prevailing among them. Deficiencies in the plant and the want of modern appliances and proper accommodations would create embarrassment, while the location, once remote from populous centres, but now

no longer isolated, would at once be recognized as hazarding the safety of the neighboring population.

It is in recognition of these facts that the health authorities of the various States and cities interested have contributed their influence to the establishment of the national quarantines, using them as refuge-stations.

Among the State and local quarantines, variety of type is presented by those of Boston, New York, Louisiana, Galveston, Philadelphia, Baltimore, and Charleston. The first four of these are complete in themselves, and independent of extraneous aid. The others make use of the national stations, particularly for the anchorage and cleansing of foul ships. The city of Charleston, for example, has a complete plant of approved modern design for the disinfection by steam of clothing, baggage, and bedding, but use is made of the neighboring national station at Blackbeard Island for the treatment of the infected vessel.

To complete this description of maritime quarantines it only remains to mention the special characteristics of the State quarantine establishments of New York and Louisiana.

THE NEW YORK QUARANTINE.

This consists of—

1. A ship, or hull, anchored in the lower bay,—the bay farthest from the city. The hull is anchored about 4 miles inside of Sandy Hook, and about 11 miles from New York. This is the boarding-station from May until November, vessels being visited by means of a row-boat.

2. Swinburne Island,—called also Dix Island,—located two or three miles from the boarding-station, nearer to New York, with an area of two or three acres, on which are erected the hospitals for the treatment of the sick, and also a cremation-furnace.

3. Hoffman Island,—like the former, an artificial island,—still nearer to New York by about one mile, on which are buildings for the accommodation of two thousand immigrants, with

interior arrangements for their division into groups, while awaiting the development of any contagious or infectious disease among them. A steam disinfecting-apparatus for the dry or moist heat disinfection of baggage, clothing, etc., has been established upon this island.

4. Residence of the health officer, on the "Narrows," near Clifton, Staten Island, 6 miles from New York.

5. The Anchorage, where infected vessels are treated. This is also in the lower bay, which is of so great area that a safe location of the vessel is easily effected.

THE LOUISIANA QUARANTINE.

To the Louisiana State Board of Health and its successive presidents, Drs. C. B. White, Samuel Choppin, Joseph Jones, Joseph Holt, and C. P. Wilkinson, is due the credit both of combating the pernicious theory of non-quarantine and of perfecting a system of quarantine that is recognized as the most extensive and efficient ever devised, and from which a number of others have been modeled. Though utilizing the devices of others, notably that of Quarantine Officer Dr. Perry, for generating and forcing into vessels' holds sulphur dioxide, and though his plant has been improved by his successor, nevertheless the credit of this new and thorough system is justly given to Dr. Joseph Holt, President of the Board of Health from 1884 to 1888, to whose determined energy and genius sanitary and commercial interests are equally indebted.

The improved quarantine consists of, first—

The Mississippi River Quarantine Station. This is located about 90 miles below New Orleans and 4 miles above the "Head of the Passes," or point where the river divides into its three main outlets.

The plant consists of five buildings exclusive of out-houses, viz., a disinfecting-shed and boiler-room, quarters and mess-hall for the disinfecting-crew, boat-house and boatmen's quarters, and two residences for the quarantine officer and his assistant.

The disinfecting-shed immediately adjoins a wharf built in water of sufficient depth to allow the largest vessels to be moored alongside.

The following description is from the report of Dr. C. P. Wilkinson, President of the Louisiana State Board of Health:—

The disinfecting apparatus consists of three cylindrical steel chambers and appurtenances, each cylinder being 50 feet long and 8 feet in diameter. The ends are spherical, and that facing the river or front end is movable, swinging open by means of a crane. At a point 50 feet in front of each cylinder commences a double, iron, elevated track, which, by a movable section, continues into and throughout the length of each cylinder.

On this track rolls a truck 48 feet in length, and from this truck are suspended thirty clothes-racks of 5 bars each. The interior of each cylinder contains an arrangement for the employment of moist and dry heat, separately and together. The necessary heat is supplied by a 40-horse-power steam-boiler at 85 to 100 pounds' pressure.

Surmounting the shed is a cypress cistern, the bottom of which is 41 feet above the river-surface, capable of holding 7000 gallons of fluid. In this cistern is stored a solution of mercuric chloride, 1 part to 1000 of water by weight. Pipes lead from this cistern to the outer edge of the wharf, and at that point have rubber-hose attachments of sufficient length to lead to all parts of a very large vessel, and the hoses terminate in hard-rubber roses of 6-inch face.

The fumigating apparatus, heretofore on a tug, but now proposed to be erected on rail-cars on the wharf, consists of a reverberatory sulphur-furnace, with 250 feet of galvanized-iron conductors, 12 inches in diameter, and a steam fan. The furnace, 24 inches wide, 48 high, and 40 deep, is provided with four cast-iron pans, 30 inches long, 23 wide, and 4 deep, each pan having over $1\frac{1}{2}$ cubic feet capacity, or about 175 pounds of sulphur. The pans are set on split brick, and are so placed that the current of air driven by the fan into the bottom passes over each pan of burning sulphur alternately, out through the top and along the conductors down into the holds of vessels.

The process of disinfection of vessels consists in placing all baggage, bedding, curtains, carpets, linen, etc.,—in fact, all textile fabrics of vessel, crew, and passengers,—on the suspended clothes-racks, which are then drawn into the cylinders by a windlass, and applying dry heat until the thermometers mark 185° F. (85° C.), at which point moist heat is turned on, the temperature rapidly rises to 215° to 220° F. (102° to 105° C.), and

the gauges usually record a pressure of 7 pounds to the square inch, at which point the blow-off valves open, preventing any danger of explosion. The contents of the chambers are kept at this temperature and pressure for thirty minutes, the cylinders are then opened, and the goods turned over to their owners. The vessel in the meantime is washed down—cabins, forecastles, decks, and holds—with the mercuric-chloride solution, and fumigated by means of the furnace and fan. In the case of loaded vessels, washing the interior is omitted, on account of danger to cargo. The holds are, however, thoroughly fumigated, and, by a special arrangement of "cargo wells," the gas penetrates every interspace of cargo. These wells are constructed at port of departure, and consist of a long wooden box about two feet across, and reach from the bottom to top of holds, the cargo being stowed around them at loading-point. The conductor from the sulphur-furnace is led into the well, the hatches are tightly closed, and, under pressure, the fumes of sulphur are driven into the vessel, the gas passing around every package envelope, no matter how tightly packed, and chemical examination showed that in the case of sugar-bags it penetrated to the depth of three-fourths of an inch. The character of cargoes arriving here from infected ports is almost exclusively coffee and sugar, the former always, and the latter nearly always, in bags, neither offering obstacles to good and sufficient fumigation *in situ*.

When necessary, the cargo is shifted to lighters for more thorough disinfection.

Passengers are required to don their disinfected wearing-apparel to permit disinfection of that they may be wearing on arrival.

Most all of the quarantine work is accomplished at this Mississippi River Station.

The second or Lower Quarantine Station is situated in Pass à L'Outre, an unused outlet of the Mississippi, a few miles below the Head of the Passes. At this station is the lazaretto, or hospital for infectious diseases, and it is the anchorage also for infected vessels.

Other stations are the Advance Guard Inspection Station at Port Eads, 110 miles below New Orleans, where the waters of South Pass are jettied into the Gulf, and the Rigolets and Atchafalaya Stations. The two latter control the two lateral approaches to New Orleans, and, as the shipping coming through these two channels is light in tonnage and mostly from domestic

ports, by imposing a quarantine of forty days' detention the two approaches are practically closed, compelling all vessels to seek the Mississippi as the only available route to New Orleans.

The following description is for the most part *verbatim*, from the pen of Dr. Joseph Holt (see "Transactions of the American Public Health Association," 1887, vol. xiii):—

When an inward-bound vessel comes into the offing, she is immediately boarded by a thoroughly skilled medical officer, and a careful inspection is made of her sanitary record and present condition. If from a non-quarantined port, and all is well, she is given *pratique* and goes on to the city. If from a quarantined port, but presenting a clean health-record of voyage and no evidence of sickness of a dangerous or doubtful character, she proceeds to the Mississippi River Quarantine Station, where she is subjected to a full course of sanitary treatment, and is detained such length of time, not exceeding five days (except in rare instances wherein further observation may be deemed necessary), as the Board of Health may provide.

If, upon inspection of a vessel entering the river she is found to be foul,—that is, showing positive or suspicious evidence of infection either in a person then ill or in a foul health-record of voyage,—she is at once remanded to the lower station in Pass à L'Outre. The sick, if any, are at once removed to the hospital, where every provision has been made. The vessel with the well on board is dropped down-stream a few hundred yards and anchored. The quarantine tug-boat, with its complete disinfecting outfit, comes alongside, and the work of disinfection begins, and does not cease until the vessel has been subjected to the most vigorous application of the solution of bichloride of mercury, her atmosphere below deck completely replaced with one heavily charged with sulphurous oxide, and every article of baggage and ship's wardrobe has been saturated with the mercuric solution.

A ship known to be infected with one of the three great pestilential diseases—small-pox, cholera, or yellow fever—can stand and must endure extraordinary treatment, even if clothing is wetted and some articles damaged.

The immediate segregation of the sick and the well and disinfection of the ship and all baggage (in the case of a cholera-infected vessel, extended to the disinfectant washing out and refilling of the water-tanks, destruction of the food-supply, and revictualing the vessel) constitute the treatment of an infected vessel at this station. The ship, together with all on board, is held for observation a period of ten days or more,

according to circumstances, when she is released and proceeds to the Mississippi River Station, where the processes of sanitary treatment are repeated, with the addition of the use of moist heat applied to baggage, ship's apparel, etc.; and the vessel is then allowed to proceed to the city.

The tug-boat mentioned is of sufficient power to move a vessel to or from the wharf, and is equipped with a complete outfit for generating and applying germicidal gas for the displacement of the entire atmosphere within the ship, transported, perhaps, directly from some infected port. In the hold of this tug is constructed a wooden tank of 2000 gallons capacity, to hold the bichloride-of-mercury solution, for treatment of vessels in the lower quarantine. This tank is furnished with a steam-pump made of iron (on account of the greater resistance of that metal to amalgamation), supplied with a $\frac{3}{4}$-inch rubber hose.

The quarantine procedure at the Louisiana quarantine stations may be further understood through the following quarantine proclamation by the Governor of the State, May 1, 1890:—

EXECUTIVE DEPARTMENT, STATE OF LOUISIANA.

In conformity with the provisions of Section 3049 of the Revised Statutes of the State, and upon the advice of the State Board of Health, requesting the Governor to issue his annual proclamation of quarantine against the hereinafter enumerated and mentioned ports, to take effect from and after the 1st day of May, A.D. 1890, to wit:—

All vessels arriving at the several quarantine stations in this State, together with their crews, cargoes, and passengers, shall be subjected to inspection by the quarantine officers at said stations.

All vessels, together with their cargoes, crews, passengers, and baggage arriving at the Mississippi River Quarantine Station from intertropical American and West Indian ports shall be subjected to thorough maritime sanitation according to the following schedule, to wit:—

First Class.—Vessels arriving from non-infected ports.

Second Class.—Vessels arriving from suspected ports.

Third Class.—Vessels arriving from ports known to be infected.

Fourth Class.—Vessels which, without regard to port of departure, are infected; that is to say, vessels which have yellow fever, cholera, or other contagious or infectious disease on board at time of arrival, or have had same on voyage.

Vessels of the first class to be subjected to necessary maritime sanitation at the Mississippi River Quarantine Station, without detention

of either vessel or persons longer than may be necessary to place such vessel in perfect sanitary condition.

Vessels engaged in the tropical-fruit trade and coming from known non-infected localities, and whose sanitary condition and health-record are satisfactory, may be allowed to pass the quarantine station after inspection, subject, however, to such regulations and sanitary treatment as the Board of Health may prescribe.

Vessels of the second and third classes to undergo the same conditions as those of the first class, together with detention for observation for a period of five full days from hour of arrival in quarantine.

Vessels of the fourth class to be remanded to the Lower Quarantine Station, there to undergo sanitation and detention of vessel and persons such length of time as the Board of Health may determine.

All vessels arriving from ports known or suspected to be infected with cholera or small-pox, or which may hereafter become infected, shall be subjected to maritime sanitation and such detention as the Board of Health may determine.

Vessels arriving from the above-named ports and places, and belonging to the second, third, and fourth classes, as is set forth in the above schedule, shall not be allowed to pass the Rigolets, the Atchafalaya, or Lake Charles Quarantine Stations, or other State quarantine stations which may hereafter be established, without having undergone a period of detention of forty days and thorough cleaning and disinfection.

Now, therefore, I, Francis T. Nicholls, Governor of the State of Louisiana, have thought proper to issue this, my annual proclamation of quarantine, directing that quarantine shall take effect from and after Thursday, the 1st day of May, A.D. 1890, against the above-mentioned ports, and as contained in the foregoing schedule.

Quarantine officers at the several stations in this State are especially charged and required to strictly enforce the execution of this proclamation, and the Board of Health in the city of New Orleans is requested to prosecute vigorously all violations of the same, as well as the quarantine laws and regulations of this State.

In testimony whereof I have hereunto affixed my signature, authenticated with the seal of the State of Louisiana, at the city of Baton Rouge, this eighteenth day of April, in the year of our Lord one thousand eight hundred and ninety.

FRANCIS T. NICHOLLS,
Governor of Louisiana.

By the Governor:

GEO. SPENCER,
Assistant Secretary of State.

Special Suggestions to Owners, Agents, Masters of Vessels, and Passengers.

The Louisiana State Board of Health recommends the following suggestions to agents, owners, masters of vessels, and passengers for the purpose of facilitating the work of quarantine officers and reducing the period of detention to a minimum :—

1. That vessels should be stripped during the quarantine season of all woolen hangings, carpets, curtains, and such-like materials, and upholstered furniture as far as practicable. Hair or moss mattresses to be replaced by wire or wicker beds.

2. That as far as possible vessels trading with tropical ports should be manned with acclimated crews.

3. Masters of vessels and ship and consular agents are earnestly requested to instruct passengers from quarantinable ports to dispense, as far as possible, with baggage which may be injured by wetting, in case of pestilential outbreak on board, while undergoing disinfection. Such passengers are especially warned against bringing silks, laces, velvets, and other fabrics of delicate texture, as they will be compelled to assume all risks of injury.

4. While in ports infected with yellow fever, vessels should be anchored out in the harbor, when this is possible, and the crew prohibited from going ashore, especially at night.

5. When practicable, cargoes should be loaded in such a manner as to allow access to the pumps, and also to enable the quarantine officials to pump out and wash the bilge.

6. Special attention should be given to cleanliness of vessels and persons, and provision should be made for all possible ventilation of the entire vessel. The best disinfectants and instructions for using the same can be obtained by application to the Board of Health or any of its officers.

7. Masters should, before arrival, see that the bilge is thoroughly pumped out and cleansed, and that the entire vessel be put in such good sanitary condition as to permit of the least possible detention. Fruit vessels, particularly, should be kept thoroughly cleansed for the purpose of avoiding delay at the quarantine station.

8. Vessels observing the above recommendations will receive special consideration at the quarantine station, detention and cost of cleaning, disinfecting, etc., being materially lessened thereby.

QUARANTINE CONTRIVANCES.

Of modern contrivances first should be mentioned the disinfection steamer. This must be a powerful boat on the

general plan of a tug-boat, about 85 feet in length on the water-line, provided with iron tanks of at least 2000 gallons' capacity for holding the solution of bichloride of mercury, to which may be attached a steam-pump and rubber-outlet hose. To prevent contact of the mercury with the iron the tanks may be painted with three coats of red lead and two of paraffine paint (Holt).

The steamer is also provided with a steam-fan, by means of which fresh air may be made to displace foul air in the hold of the vessel under treatment. A sulphur-furnace is also provided for the generation of sulphur dioxide, which is conveyed into the hold of the adjoining ship after displacement of the foul air.

The improved pattern of sulphur-furnace is the design of Assistant-Surgeon Kinyoun, Marine-Hospital Service, who states that it is on the principle of a reverberatory furnace, consisting of a series of shelves arranged one above another, each shelf holding a pan of burning sulphur. A forced draught is kept up by means of a fan-blower connected at the bottom. The draught of air charged from the burning sulphur of each shelf is made to reach and pass over the shelf above by means of apertures made by shortening the shelves alternately at their rear and front extremities. With an experimental furnace Dr. Kinyoun states that "repeated experiments gave from 14 to 16 per cent. of SO_2, temperature 21° C., while burning sulphur in a closed place gave only 6 per cent. at 21° C., *i.e.*, it would not support the combustion of sulphur above that percentage.[1]

The furnace belonging to the fumigation vessel of the Louisiana Board of Health is of a special pattern. Dr. Salomon, secretary of the board, states that for each vessel 200 to 800 pounds of sulphur will be used, according to the size of the vessel, and the fumes will be allowed to remain in the hold, with hatches sealed, twenty-four to thirty-six hours, or longer.[2]

[1] See Abstracts of Sanitary Reports, Marine-Hospital Service, vol. iii, pages 347 and 348.

[2] See Transactions of the American Public Health Association, vol. xiii, for Dr. Holt's description of his system, and vol. xiv, page 113, for Dr. Salomon's reports and improvements thereon.

The amount of sulphur used at the New York Quarantine by the pot method (pots of burning sulphur lowered into the hold) is 50 to 100 pounds, according to the vessel's size).[1]

At Pensacola about 12 pounds of sulphur are used to every 100 tons' register, and the fumigation lasts twelve hours.

At the Delaware Breakwater 4 pounds are used to each 1000 cubic feet of space, and the fumes are kept twenty-four hours in the vessel's hold. At Chandeleur, 35 pounds in hold to 100 tons.

STEAM DISINFECTING-CHAMBERS.

The principle of disinfection by steam was first advocated by Dr. A. N. Bell, of Brooklyn, but the contrivance about to be described was first used by Dr. Joseph Holt, and improved by Dr. Wilkinson and others. These chambers, two or three at one station, consist of jacketed, cylindrical shells, made of strong boiler-iron, each shell being 40 or 50 feet long and 7 or 8 feet in diameter, inside measurement, furnished with doors at each end.[2]

The jacketing is for the purpose of using the chambers with either dry heat or with superheated steam.

Articles of clothing, bedding, etc., are arranged on trucks, which are run into the chamber at one end and taken out at the other. A bacteriological test made by Dr. Kinyoun at the Louisiana Quarantine Station showed that all germs were killed after exposure to a dry heat of 79.4° C., obtained in sixteen minutes, steam then being turned on for twenty minutes.[3]

Another and simple contrivance for fumigating is the "Liquid Sulphurous Dioxide," the compressed gas furnished in metal reservoirs, which, being opened, the gas rapidly escapes. By this means any proportion of SO_2 can be introduced in a vessel without any apparatus. It is manufactured in Hagenau and in Oberhausen, Germany, and may be purchased in New

[1] See Report by Dr. John H. Rauch upon an Inspection of the Atlantic and Gulf Quarantines, State Printer, Springfield, Ill., 1886.

[2] See description under "Louisiana Quarantine."

[3] For plans and specifications, see Annual Report Marine-Hospital Service for 1889, and Abstract of Sanitary Reports, vol. iv, page 443. For Dr. Kinyoun's experiments, see Abstract Sanitary Reports, vol. iii, pages 117 to 147.

York, and of Finlay & Brunswig, wholesale druggists, New Orleans, at a cost of five cents per pound when not less than one ton is taken. It has been suggested that this may take the place of the sulphur-furnace and appliances on the steamer. The cost by this method is thought to be but little, if at all, greater than by the furnace method, if the interest on the plant is added to the latter. This method has been occasionally used at the Grosse Isle Quarantine, in Canada, but to establish its complete practicability will require further test.

ADMINISTRATION OF MARITIME QUARANTINE.

The following are the rules and regulations of—

1. The National Quarantine Stations.
2. State Quarantine Service of Texas.
3. The Local Quarantine at Pensacola, Florida.

In these three types will be found all the ordinary administrative regulations, which are, however, subject to minor changes yearly.

1. Regulations for the National Quarantine Stations.

(From the Regulations of the Marine-Hospital Service, 1889.)

328. At ports where quarantine may be established by special statute or by the Secretary of the Treasury, every vessel, before being permitted to enter, shall present to the Collector of Customs satisfactory evidence either that said vessel had not, at any time during a period of thirty days immediately preceding its arrival, touched at or communicated with any foreign port where cholera or yellow fever exists, or small-pox was known to exist in an epidemic form; that there had not been at any time during that period any case of contagious disease on board; and that said vessel does not convey any person or persons, merchandise, or animals affected with any infectious or contagious disease, or that the said vessel has been thoroughly cleaned and disinfected by the quarantine officer, and is free from infection at the time of entry. The certificate to that effect, of the medical officer of the Marine-Hospital Service, acting as quarantine officer for the United States at the port, shall be accepted by the Collector of Customs as satisfactory evidence, and the medical officer shall, before granting such certificate, satisfy himself that the matters and things therein stated are true.

329. Vessels coming from a foreign port or country where cholera

or yellow fever exists, or small-pox is known to have existed in an epidemic form within thirty days preceding their arrival, and vessels or vehicles conveying any person or persons, merchandise, or animals affected with any contagious disease, or having had on board at any time during the thirty days preceding their arrival any case of contagious disease, shall not enter any port of the United States until such disinfection or other precautionary measures shall have been performed as prescribed by these regulations, and the certificate of the medical officer of the Marine-Hospital Service, or other designated agent of the Treasury Department, shall, in such cases, as in the cases referred to in the preceding paragraph, be accepted by the Collector of Customs as satisfactory evidence of compliance with the regulations.

330. Quarantine stations will be governed by the general regulations of the Service, so far as applicable.

331. No pilot or other person will be allowed to leave a vessel until the vessel shall have been inspected by the quarantine officer, and any person violating this regulation shall be reported to the nearest United States attorney for prosecution under the act of August, 1888, and no person will be allowed to leave the quarantine reservation, or a vessel placed in quarantine, without permission of the quarantine officer.

332. Quarantine officers are hereby empowered and authorized to cause the temporary arrest of any person violating the quarantine regulations, and turn them over to the custody of the nearest United States marshal, and notify the United States attorney to that effect; or, if that be impracticable, to confine them on the quarantine reservation, subject to the orders of the said marshal or attorney.

333. When a vessel arrives at a United States quarantine boarding-station, the inspecting officer will examine the papers of the vessel to inform himself of her passengers and cargo; he will require all persons named on the passenger-list and crew-list to present themselves and answer to their names at muster. Should any person have died on the voyage, the circumstances of the death will be inquired into, and, in case of there being any person sick, such person will be carefully examined by the inspecting officer, the only exception being, in case of naval vessels, the statement of the senior surgeon or medical officer as to the sanitary condition of the vessel will be accepted.

334. When persons are found sick of cholera, small-pox, yellow fever, plague, or diphtheria, they shall be immediately removed to the quarantine hospital, and the vessel be thoroughly disinfected.

335. In order to stimulate ship-masters to aid in securing a clean ocean-going fleet, the following regulations concerning the treatment of foul ships will be observed at all national quarantine stations:—

When a vessel arrives at any national quarantine station from an infected port, and requires disinfection, she will be subjected to *ordinary disinfection*, as provided in former regulations.

When any vessel shall arrive at a national quarantine station in such foul condition as to render her dangerous from a sanitary point of view, and is found to require cleansing and disinfection, having at any former time within one year been subjected to ordinary disinfection, such vessel will be required to undergo *extraordinary disinfection*, which, in addition to the ordinary measures, will include holy-stoning, scraping, the taking out of rotten wood, a second disinfection, and interior repainting, all of which will be required before granting a certificate of free *pratique*.

336. The recognized method of disinfection of vessels will be, for all vessels: *a*, by bichloride of mercury; *b*, by sulphurous oxide; *c*, by flushing with sea-water.

337. For disinfection of clothing and other fomites, dry heat will be used whenever practicable, and when it is not practicable to use dry heat the sulphurous-oxide fumigation will be used.

338. The Supervising Surgeon-General will from time to time issue detailed instructions for the practice of disinfection, under these regulations, which instructions will include such improvements as may be suggested by the advance of science.

2. Quarantine Regulations, State of Texas.

General Rules.

No. 1. After the declaration of quarantine by the Governor, every vessel, before entering any port on the coast of Texas, shall be boarded by quarantine officers, and the crew and passengers be subjected to such questions by said officers as will be necessary to determine their probable connection with epidemic influence or infectious diseases.

No. 2. Vessels hailing from infected districts, or having communicated with others from such districts, by contact or otherwise, shall be placed in quarantine, casting anchor at such place or places as may be designated by quarantine officer of port, and a complete list of both crew and passengers taken. Notice in writing shall be given captains, holding them responsible for strict non-communication of both passengers and crew with other vessels or with any one from shore. Violation of this rule shall be punished by fine against vessel and captain, not less than $500 or more than $1000.

No. 3. From the masts of all vessels in quarantine shall be displayed a yellow flag, of such dimensions as to warn off others approaching.

No. 4. All vessels held in quarantine shall be under the direction of port quarantine officer, and put in thorough sanitary condition by fumigation of hold, washing decks with disinfecting fluids, and purifying bilges, etc.

No. 5. Costs of fumigation, disinfection, etc., shall be at expense of vessels.

No. 6. A complete muster of crew and passengers must again be taken before vessels are given free *pratique*, and a concise report made to State health officer. No vessel shall be finally released without permission of State health officer.

No. 7. Families of quarantine officers will not be allowed at stations without special permission from State health officer during the existence of quarantine.

Pilots.

Pilots will not be allowed to visit, or board, or communicate with any vessels without permission of port quarantine officer, under penalty of forfeit of their commissions as such.

Market Vessels.

Market vessels—meaning those which belong at the port, and which furnish daily supplies to vessels at anchor or in quarantine—shall, in every instance, apply to quarantine officer for permission before attempting to trade or communicate with such vessels; and in case of violation of this rule shall themselves be placed in quarantine and held at discretion of officer in charge.

Vessels with Cargo to be Disinfected.

Any vessels from infected districts which may desire to enter such cargo shall, upon arrival at outer bar, make known their intention to quarantine officer. Quarantine officers receiving this cargo at quarantine warehouse shall employ, as far as possible, only acclimatized men, and said employés shall be kept under quarantine themselves a sufficient number of days to determine their probable infection, their clothing and other articles capable of conveying infection be subjected to a high temperature, say 220° F. (105° C.), before being allowed to return to cities or shore. The crews of said vessels shall be subject to rules as above, and such other precautions as may be deemed requisite at the time by State health officer. Costs in this instance, as in others, are chargeable to owners of cargoes.

3. Quarantine Regulations at Pensacola, Florida.

(Issued by the Escambia County Board of Health.)

1. The port inspector shall visit and inspect every vessel entering the bay of Pensacola, and ascertain and report her sanitary condition; and until such inspection and report, and the release of such vessel by said officer, no person shall visit her, and no person from her shall visit

any other vessel or the shore. The master or owner of each vessel so inspected shall pay to this Board for such services $5.

2. No vessel coming into the port of Pensacola, having on board any contagious or infectious disease, or from a port where any such disease prevails, shall remain within the territory under the jurisdiction of this Board, except at a point designated and under restrictions imposed by this Board, according to the exigencies of each case.

3. It shall be the duty of any person coming into the county of Escambia or port of Pensacola, from any locality where any disease in an epidemic form prevails, to report at once to this Board or some officer thereof, and no person coming from any such locality shall remain in said county without the permit of this Board, and then only at such point as may be designated, and under such restrictions as may be imposed by this Board, according to the exigencies of each case.

4. No ballast brought into the bay of Pensacola by vessels shall be discharged in the county of Escambia, or the waters separating that county and the county of Santa Rosa, except at such point as may be designated in a permit obtained from this Board or granted on its authority; and in case this Board or its sanitary inspector or other officer, with approval of this Board, deem it expedient for the preservation of the public health to require fumigation, disinfection, or discharge of ballast at quarantine station, the same shall be done at the expense of the vessel, and in accordance with the system in use by this Board.

5. All pilots and tow-boats of the port of Pensacola shall be supplied with copies of these rules, and every pilot or tow-boat master speaking or boarding a vessel coming into said port shall hand a copy thereof to the master of said vessel.

6. In case any vessel shall be required, by authority of this Board in the exercise of its powers to preserve the public health, to discharge ballast at quarantine station or be fumigated, she shall pay 25 cents per ton for the ballast discharged, and for the fumigation shall pay as follows: Steam-ships, $75; ships, $50; barks and other vessels other than brigs and two-masted schooners, $40; brigs, $20; two-masted schooners, $15.

7. No pilot, tow-boatman, or other person shall remove, transfer, or receive, or assist in removing, transferring, or receiving any person from any vessel entering the bay of Pensacola until such vessel shall have been inspected and released by the port inspector.

QUARANTINE PRACTICE.

The practical duties of administration, particularly the inspection and treatment of vessels, are well described by the

medical officers in command of the several stations named in the following letters:—

GULF QUARANTINE STATION, CHANDELEUR ISLAND, MISS.

(Letter from P. A. Surgeon H. R. CARTER, U. S. M.-H. S.)

I board the incoming vessel while under way and give her such a berth as in my judgment is suitable.

When she is at anchor I first examine her papers, bills of health, crew-list, and log; questioning the master at the same time on such points as may bear on the sanitary condition of his vessel; and, except in the case of Dr. Burgess's papers, given at Havana, far more valuable information will be given by, or may be extracted from, the master than is conveyed by the bills of health. The master is asked how long he lay at the port of clearance, especially *where* he discharged and *where* he lay; there being, for instance, as much difference in the liability to infection between different wharves in Havana, or between the Gamboa and the Coal Islands in Rio, as between different ports.

I especially ask for the cause of discharge of men left (generally in hospital) at the port of clearance, and mark the substitutes shipped there for special examination. These men having probably been ashore for some time and quite frequently just out of hospital, where they were left by other vessels, are occasionally the means of introducing yellow fever aboard a vessel healthy until they are shipped.

The statements of the master and even the log (except in British vessels) are naturally to be taken with some "personal correction" dependent on circumstances, and which has wide limits. In general, I think intentional false statements are extremely rare, but statements of damaging facts may not readily be volunteered.

The vessel is then inspected. I go all over it, into every place, noting especially the sleeping-places and bedding, water-closets, character of ballast, and condition of the hold and forecastle, as regards cleanliness, ventilation, and dryness; whether the air streaks are open; if the ports have been open recently, or the wind-sails show signs of recent use. In the hold, aft and forward are most apt to be dirty. If the ballast has been recently trimmed and the crew is healthy it is a good sign; on the other hand, it may account for a sudden outbreak of fever after she puts to sea, in a ship previously healthy.

The bilge is examined by pumping, if in ballast; by lifting a timber-plank if not; and on the smell more stress is laid than on the color.

I inspect the ship before I do the crew, so that I may see the crew when they are not aware they are under observation. I then inspect the crew. All stand together, and as I call the roll each man answers,

comes to me, and passes to another place. Any I wish to examine more closely are told to step aside. These would in general be: Those who look sick, or as if they had been sick; those who by the log or master's statement had been sick; those who had shipped at port of clearance. They are examined as may be deemed necessary. In these cases little dependence can be placed on the accounts sailors give of their past ailments, and a kind of inverse malingering is universal. For instance, the cabin-boy of the "Maria," with yellow fever, was standing up, although holding by a chair, and reported himself as perfectly well and "could eat much," then staggered and had fallen had I not caught him in my arms, vomiting as he fell.

We have no cargoes, save occasionally a schooner with fustic, log-wood, or sisal.

The baggage is examined when unpacked for disinfection.

If the vessel is infected and has sick men aboard, I attend to the sick first, and remove them if possible. Right here I may say that in some stages of yellow fever removal is not possible with safety to the patient—it means death to him. In this event, he should be isolated on board ship, having already had the disease two or three days, and thereby having already exposed the vessel. As soon as possible, however, he should be removed.

A preliminary fumigation and disinfection is done immediately before doing anything else, in the hope of destroying the contagium at its source, and preventing the sickness of others of the crew. This is done as thoroughly as possible without removing ballast or much preliminary mechanical cleaning, but particular attention being given to the probable source of infection. The vessel is then treated in the routine manner, as follows:—

The bilge is first pumped out and washed until clean, after which the disinfectant is put in,—generally bichloride of mercury. At Chandeleur we have practically no cargoes to deal with. The ballast therefore is next removed. All sand, earth, porous stone, or other foul ballast is removed—thrown overboard. The work is done by the ship's crew. Clean, sharp stone—as much as may be necessary to hold the vessel, *i.e.*, prevent her capsizing—may be allowed to remain, each stone having been immersed in a 1 to 800 solution of bichloride of mercury. This is done by the crew while trimming ballast,—a necessary procedure, irrespective of disinfection. The hold is washed down with sea-water by means of a force-pump, birch and whalebone brooms being also used, and, if necessary, scrapers. The same is done to the forecastle and other parts, if necessary.

The vessel being mechanically clean in its accessible portions, the

disinfection is begun. All soiled or used clothing, and all bedding that can be so treated without destruction, is soaked for half an hour in bichloride solution. The remainder is hung up loosely for fumigation. Not unfrequently there are articles—cotton-stuff comforts, etc.—which cannot be disinfected, and are, therefore, destroyed. All articles not capable of conveying infection, as chronometers and articles made from the precious metals, are removed. The cabin, forecastle, and hold are then fumigated. For close vessels the amount of sulphur used in the hold is 35 pounds per 100 tons. The cabin and forecastle are kept closed twenty-four hours, the hold from forty-eight to seventy-two hours. In an ordinarily tight ship it is impossible to enter the hold, even after seventy-two hours, until the fumes have been displaced by air from wind-sail and open ports. When the doors are opened all surfaces are washed with a solution of bichloride, either with hose and brooms or with mops. Gilt-work, being utterly destroyed by this agent, is washed with water as near boiling as it can be used.

The quarantine detention of the vessel now begins. The proper time in quarantine is not less than the period of incubation. The number of days of passage from foreign ports counts for nothing, as does also the time on the quarantine grounds previous to completion of disinfection.

In estimating the probability of a vessel being infected, it makes quite a difference whether the yellow fever she has had in passage developed at such time that it could have been contracted elsewhere than on board ship, or so long after clearing as of necessity to have been communicated by the ship or fomites aboard her. In the latter case she was infected. This has a direct bearing on her treatment.

South Atlantic Quarantine Station, Blackbeard Island, Ga.

(Description of Quarantine Methods, by Passed-Assistant-Surgeon J. H. White, U.S.M.-H.S.)

On boarding a newly-arrived vessel, I *first* demand the crew-list and passenger-list (if any). I have the roll called, and, when all have answered, inspect each and every person, with a view to the discovery of any signs of present or recently-passed sickness, of any character.

The cabin, forecastle, galley, and any other rooms are then inspected, and every chest and locker opened and contents seen.

The hold and between decks are next inspected. All sick are removed to hospital.

This constitutes the first step.

The *second* consists in putting into all these places a preliminary fumigation with sulphur of sufficient quantity, this process occupying about twenty-four hours.

Third.—All ballast is removed when possible, and when not so it is dipped stone by stone in bichloride solution of the strength of 1 to 300 or 1 to 500, and the whole vessel is washed as clean as water can make her,—hold, deck-houses, and all.

Fourth.—Another, and even stronger fumigation than the first, with sulphurous-acid gas.

Fifth.—With a force-pump and hose, a solution of bichloride (1 to 500, or stronger) is freely applied to every part of ship and contents. Clothing, both in use and not, is either burned, boiled, or soaked in a 1 to 500 solution of bichloride; sometimes both the latter measures. Soaking lasts ten to fifteen minutes. Clothing is boiled twenty minutes; bedding two to three hours. Bedding is most often burned, and always after small-pox.

Delaware Breakwater Quarantine Station.

(Inspection and Treatment of Vessels, by William P. Orr, A. A. Surgeon U. S. M.-H. S.)

The plan which I have followed in inspecting vessels at this station is as follows:—

I first go down into the cabin and examine the bill of health (and manifest, if the vessel has a general cargo). From these I learn the following important facts: The sanitary condition of the port of departure at the time of sailing; the date of departure; number of crew and passengers, and whether the vessel sails in quarantine or free *pratique*. I will say just here that the bills of health issued by Dr. Burgess, an Inspector of the Marine-Hospital Service, stationed at Havana, are the most complete and satisfactory bills of health that I examine, and we have vessels coming to the Breakwater from all over the world. He always gives the sanitary history and condition of the vessel, cargo, crew, and passengers, and the number of cases and number of deaths from contagious diseases during the week previous to the departure of the vessel.

If on arrival there is no sickness on the vessel, and there has been none during the passage, and there is no infectious or contagious disease at the port whence she sails, then the vessel is discharged from quarantine. If there is any contagious disease on board on arrival, the sick are brought ashore and cared for in hospital, and the vessel fumigated, disinfected, and detained for a variable period, usually ten days, in order to observe the crew and see whether any new cases are going to appear. If the crew are all well on arrival, but have had sickness (by sickness I mean yellow-fever, small-pox, or cholera) during the passage, the vessel receives the same treatment as above. In case the crew are all well, and there has been no sickness during the passage, but the vessel comes from

an infected port, then the treatment of the vessel depends upon the number of days' passage, the condition of the vessel, the statement of the captain (which is made under oath) as to whether the crew were allowed to visit the shore, and the length of time the vessel was in port discharging the cargo and reloading, and other considerations which enable us to decide whether any danger need be apprehended in allowing the vessel to enter. After careful inspection of a vessel from an infected port, if I find everything neat and clean, I usually allow her to proceed, provided she has had a passage of ten days or more; but if she has not been out for that length of time I detain the vessel, during the summer season, for observation until the ten days from date of departure have expired. At the end of this time, if no sickness appear, the vessel is discharged.

To clean an infected vessel, we begin the first day by fumigating,—that is, burn about 4 pounds of sulphur for every 1000 cubic feet of air-space, the hatchways, doors, and windows being closed and caulked, so as to make the hold, cabin, and forecastle as nearly air-tight as possible. The sulphur-fumes are allowed to remain in the hold twenty-four hours, and in the cabin and forecastle about ten hours; the second day all beds, pillows, and furniture which cannot be satisfactorily disinfected are burned, and all clothing, blankets, curtains, carpets, and cotton and woolen goods are soaked in a bichloride solution (1 to 2000). The third day the floors, walls, and ceilings of the cabin and forecastle, and all furniture, drawers, and chests in them washed with the same solution. The vessel is now supposed to be clean, and is discharged at once, provided the average period of incubation for the disease from which the crew have suffered has elapsed since there was any one sick on board.

SPECIAL MEASURES AGAINST CHOLERA.

Other features of quarantine administration are well expressed in the following extract from the editorial pages of the Philadelphia *Medical News* of October 15, 1887, showing the measures necessary to extinguish an incipient epidemic of cholera and to prevent its spread. Such measures are as follow:—

(*a*) Speedy recognition and isolation of the sick; their proper treatment; absolute and rapid destruction of the infectious agent of the disease, not only in the dejecta and vomit, but also in clothing, bedding, and in or upon whatever else it finds a resting-place.

(*b*) The convalescents should remain isolated from the healthy so long as their stools possibly contain any of the infecting agent; before

mingling again with the well they should be immersed in a disinfecting bath, and afterward be clothed from the skin outward with perfectly clean vestments, which cannot possibly contain any of the infectious material.

(*c*) The dead should be well wrapped in cloth thoroughly saturated in a solution of corrosive sublimate (1 to 500), and, without delay, *cortège*, or lengthy ceremonial, buried near the place of death in a deep grave, remote as possible from water which may, under any circumstances, be used for drinking, washing, culinary or other domestic purposes. (Cremation, of course, is by far the safest way of disposing of cholera cadavers.)

(*d*) Those handling the sick or the dead should be careful to disinfect their hands and soiled clothing at once, and especially before touching articles of food, drinking, or culinary vessels.

(*e*) In the case of maritime quarantine, the well should be disembarked and placed under observation in quarters spacious enough to avoid crowding, and so well appointed and furnished that none will suffer real hardships.

(*f*) Once having reached the station, those under observation should be separated in groups of not more than twelve to twenty-four, and the various groups should, under no pretext, intermingle. The quarters for each group should afford stationary lavatories and water-closets in perfect working condition, adequate to the needs of the individuals constituting the group, and supplied with proper means of disinfection. There should be a bed raised above the floor, proper coverings, and a chair for each member of the group, each person being required to use only his own bed. There should be a common table of sufficient size to seat around it all the members of the group, who should be served their meals from a central kitchen, and with table furniture belonging to the station and cleaned by the common kitchen scullions.

(*g*) Drinking-water, free from possible contamination and of the best quality, should be distributed in the quarters of each group as it is needed, and in such a manner that it is received in drinking-cups only. There should be no water-buckets or other large vessels in which handkerchiefs, small vestments, children's diapers, etc., can be washed by the members of any group.

(*h*) Immediately after being separated into groups in their respective quarters, every person under observation should be obliged to strip and get into a bath (a disinfecting one is preferable), and afterward be clothed with fresh, clean vestments from the skin outward. Every article of clothing previously worn should be taken away and properly disinfected.

(*i*) Then all of the personal effects should be at once removed to a

separate building, washed (if possible), and thoroughly disinfected, or, if necessary, destroyed. After disinfection they should be temporarily returned to the members of groups, when occasion requires a further change of clothing.

(*k*) Under no circumstances whatever should washing of clothing by those under observation be permitted. All used clothing should be first thoroughly disinfected (by boiling, when possible), and then should be cleansed, the disinfection and washing being done by a sufficiently trained and absolutely reliable corps of employés supplied with adequate appliances.

(*l*) All those under observation should be mustered in their own quarters, and be subjected to a close medical inspection, *while on their feet*, at least twice every day, in order to discover and isolate, as soon as possible, new cases which may develop; and, of course, the clothing and bedding of these new cases should be treated without delay in the manner already mentioned. In the meantime, a watch should be set over the water-closets for the purpose of discovering cases of diarrhœa, and, when discovered, such cases should be temporarily separated from the rest. They should receive judicious medical attention at once, and precautions should be taken as if they were undoubted but mild cases of cholera.

(*m*) The quarters should be kept thoroughly clean, and every surface upon which infectious material could possibly be deposited, including the floors, should be washed with a strong disinfectant twice daily, and oftener when necessary. Evacuations from the bowels should be passed into a strong disinfectant; the hopper of the closet should be then flushed and finally drenched with a quantity of the same disinfectant.

(*n*) For the proper attention to the sick, there should be two or more competent and experienced physicians, assisted by a sufficient corps of intelligent and efficient nurses, with hours of duty so arranged that a physician, with a sufficient number of nurses, be in constant attendance in the wards of the hospital.

(*o*) For the prompt recognition and separation of new cases, their temporary medical attention, the proper treatment of discovered cases of diarrhœa or cholerine and of other maladies, and the immediate correction of every insanitary practice or condition by constant, vigilant, and intelligent supervision, there should be at least two or more competent and experienced physicians, with hours of service so arranged that a physician is on duty night and day among those under observation; and he should have, subject to his orders at any and every moment, a sufficient and efficient corps of nurses and laborers to carry out properly and promptly his directions.

(*p*) In order to prevent the intermingling of the various groups, to enforce obedience and order, and to make it absolutely impossible for the quarantined and their personal effects to have any communication with the exterior, a well-organized and sufficiently large police corps should patrol the borders of the stations and the buildings day and night.

(*q*) Any group among whom there have developed no new cases of cholera or of choleraic diarrhœa, during the preceding eight or ten days, may be regarded as harmless, and allowed to leave quarantine after each one is finally immersed in a disinfecting bath and re-clothed with clean garments from the skin outward, the garments removed being destroyed or thoroughly disinfected and cleansed, as already indicated.

As yet no reference has been made to the crew, ship, and cargo. What has been said of the treatment of those under observation applies to every one of the ship's inhabitants. The observation, isolation, and cleansing of the crew and their effects could safely be performed aboard ship if necessary. The ship should be thoroughly cleansed and disinfected, particular attention being given to the quarters of the emigrants and crew.

AIDS TO QUARANTINE.

In aid of the national quarantines, sanitary inspectors are appointed by the Marine-Hospital Service at special points of danger, either in the United States or abroad. Through the State Department consular notification from foreign ports is received regularly by mail, or, in emergency, by cable, and the information thus received, and that received also from home ports, is communicated, by the Marine-Hospital Bureau, to all quarantine authorities and others, by means of a weekly publication known as the "Abstract of Sanitary Reports."

An important source of information concerning the movements of vessels in every portion of the world is the "Maritime Register," published in New York. The United States Collectors of Customs are efficient aids, having, by law, the power of search and detention of vessels, and having exceptional knowledge of the sanitary condition of the shipping at their respective ports. The Revenue-Cutter Service, a national coast patrol, renders efficient aid, and the light-house establishment and coast survey render valuable assistance in locating and buoying the anchorages.

Finally, the Marine-Hospital Service, having, besides the quarantines, the care of the sick of the merchant vessels of the United States, with 126 physicians stationed at all the larger and many of the smaller ports, is ready at a moment's notice to extend indefinitely its quarantine service. To the surgeon-general of this service, at Washington, are entrusted all national quarantine matters.

INLAND QUARANTINE.

Under Inland Quarantine will be mentioned The Sanitary Cordon, Camps of Probation, Railroad Quarantine, Disinfection Stations, and Inspection Service.

The Sanitary Cordon.—This consists of a line of guards, military or civil, thrown around a district or locality, either to protect the same from the surrounding country when infected, or to protect the surrounding country from the infected district or locality. When a given locality is infected, and the adjacent territory is regarded as suspicious, it may be necessary to establish a double cordon, the first one embracing the whole suspected territory at its outer edge, the second investing more closely the well-defined infected locality. After the expiration of a sufficient time to prove that the area between the cordons is not infected, or has been cleared of infection, the first cordon may be removed. Hospitals and camps of probation may be necessary adjuncts to the cordon. The most noted example of the sanitary cordon is found in the history of the plague epidemic in Russia in 1878. A colony on the river Volga, called Wetljankaja, with a population of 1700 inhabitants, became infected with the Oriental plague, which extended to the neighboring villages. A military cordon was made to embrace all the infected district. The inhabitants of the focus of infection, Wetljankaja, were removed, property appraised for re-imbursement by the government, and the village burned. An additional cordon was thrown around Zarizin, a neighboring commercial city of importance and terminus of the Russian railway system. The cordons were maintained several months, and the plague was stamped out.

(See Abstract Sanitary Reports, vol. i [Bulletin's], page 78.) The sanitary cordon is the customary method of preventing the spread of epidemic disease in the eastern countries.

In the United States, when yellow fever prevailed in Pensacola in 1882, to the extent of 2200 cases, the navy-yard reservation, whose boundary-line is within two miles of the city limit, with a population of about 1500, was successfully guarded by means of a cordon and non-intercourse.

The following year, 1883, the navy-yard itself was infected, and a cordon was thrown around it to protect the city of Pensacola, and was maintained for a period of sixty days. This cordon was under the management of the Surgeon-General of the Marine-Hospital Service, aid having been requested of the national government. The Collector of Customs of Pensacola was made the agent to execute the orders of the Marine-Hospital Bureau, and to the president of the local Board of Health was entrusted the immediate command of the line and guards. The cordon entirely surrounded the land boundary of the naval reservation. Its line was four miles in length, one mile of it through a dense thicket, and was marked by blazed trees and flags. Forty men were employed as guards, an equal number being selected from each of the two political parties. Two captains were appointed, and were obliged to supervise the line night and day.

The sentinel posts were furnished with tents, and two guards were allotted to each post, taking alternate watches of four hours each. A detention or probation camp was established and placed in charge of a physician, where persons wishing to leave the reservation were obliged to pass a probationary period of twenty days. Not more than half a dozen persons were received in this camp. The government expended about $20,000 in these restrictive measures, which were entirely successful. Not one person got through the cordon line. The success was due largely to the thorough discipline maintained by the Collector and the President of the Board of Health.

Yellow-Fever Cordon in Texas.—In 1882, yellow fever prevailing in Mexico along the Rio Grande, and in Brownsville, Texas, a sanitary cordon was established by the Surgeon-General of the Marine-Hospital Service, on request of the Governor of the State, extending along the line of the railroad from Corpus Christi, on the Gulf of Mexico, inland to Laredo, on the Rio Grande. This line was 180 miles northeast of Brownsville, the triangular territory thus hemmed in by the cordon on one side, the Rio Grande on another, and the Gulf on the third, being all suspected territory, although the fever prevailed in only one corner of it, viz., in Brownsville. All persons were detained at least ten days at the cordon before being allowed to pass northward,—a period of probation to insure that no one having the disease should carry it farther north. As soon as practicable another cordon was established much nearer to Brownsville, only 30 miles from it, the line extending from the mouth of the Sol Colorado, on the Gulf of Mexico, to Santa Maria, on the Rio Grande. After a time sufficient to prove that no more fever prevailed between the two cordons, the first one was removed. Within the second line, where the fever prevailed, chiefly in Brownsville, a hospital was established and dispensaries opened for the gratuitous treatment of all applicants.

Upon the Mexican side of the Rio Grande the fever continued to spread northwardly, and, in order to oppose it, still another cordon had to be established on the American side of the river, extending from Santa Maria on the south to Laredo on the north, a distance of 500 miles. Three hundred guards well mounted (Texan cow-boys) were employed in this cordon, and, while the disease was being stamped out in Brownsville, any further importation from Mexico was thus prevented. In Mexico the fever continued to spread until the authorities finally adopted measures similar to the above.

Much violent language has been used concerning the hardships imposed by the sanitary cordon, but in the presence of an epidemic the authorities who are responsible need to pay more

heed to the efficiency of the cordon than to individual complaints. It should be borne in mind that the sanitary cordon is not intended to bottle up all the people who are caught within an infected district. On the contrary, it is intended as a means of exit to those who will not carry with them contagious disease to the people beyond.

The cordon, then, imposes simply a period of detention corresponding to the incubative period of the prevailing disease. Ample preparation must be made for housing and feeding, in camps or other quarters, persons awaiting the expiration of the detention period; and hospitals must be provided for the treatment of those who develop sickness. Provision must also be made for the disinfection of suspected baggage.

Camps of Probation.—Camps of probation or detention should be established with all the precision of arrangement and regard for site, water, and drainage that pertain to a military camp. Every effort should be made to make the camp as comfortable and cheerful as possible, and to this latter end amusements and entertainments such as might be suggested by the campers themselves should be encouraged. Every necessity in the matter of food, bedding, and the ordinary comforts of life should be anticipated to prevent any just cause of complaint. Such a natural division of the inhabitants should be made as seems desirable at the time, those of equal intelligence and refinement naturally seeking each other's company. The greatest concern is to prevent the camp itself from becoming infected. To this end no baggage should be allowed within the camp boundary without previous disinfection; and every refugee should be examined by a physician before being admitted to the camp. No one should be received who does not intend to proceed to an uninfected locality after his probation. In other words, a camp of probation should not be used as one of refuge.

The camp must be surrounded by guards to prevent egress or ingress, excepting through the established portal. At least

twice or three times in the twenty-four hours all refugees should be inspected in their quarters, and any case of sickness at once be isolated and watched until the diagnosis is certain. If the case is one of the prevailing disease, the patient must be removed immediately to the hospital, which should be at a safe distance, half a mile or more, from the camp. Before leaving the camp, each refugee's clothing should be fumigated, and he should be given a certificate that he has passed the required period of probation. A clear distinction must be made between camps of probation and camps of refuge. Camps of refuge are simply residence camps established to receive the population of an infected community when it has been determined to depopulate the infected district.

Depopulation of a house, a block, a district, or a whole city, if possible, the people moving into camps, is now recognized as a valuable means of controlling an epidemic; and there may be either camps of probation or simply camps of refuge, or both, according to the requirements of the situation. Camps of refuge, in connection with depopulation, were suggested by the late Surgeon-General Woodworth, in 1878, and the measure was practically carried out at Memphis, in 1879, by the establishment of Camp Mitchell. "But the establishment of a camp to which persons from infected points could go, be kept under observation a sufficient length of time to demonstrate they were not infected, have their baggage disinfected, and be given 'free pratique,' is apparently a new departure in inland quarantine."

Camp Perry, Fla.—Such was Camp Perry, Florida, described by the surgeon in charge, W. H. H. Hutton, in the Marine-Hospital Service Report for 1889. The site was admirably chosen by Passed-Assistant-Surgeon John Guitéras, upon a bluff on the south side of St. Mary's River, the dividing line between Florida and Georgia, about forty miles north of Jacksonville, Fla., which city was in the throes of a yellow-fever epidemic. The camp was opened August 20, 1888. It con-

sisted, in its completed stage, first, of 50 wooden cottages built elsewhere and transported on cars. Their dimensions were 12 feet by 10, and 10 feet in height, constructed of plain lumber, with cracks battened, and windows on each side with swinging shutters. Each held four cots, chairs, and toilet-stand, while unused clothing was neatly arranged on the rafters above. Besides the 50 cottages there were a quartermaster and guard-house, commissary building, dining-room, and kitchen, and laundry, built of rough lumber; 2 Ducker portable barracks, each 18 by 35 feet, provided with 12 beds each, and 350 tents, used principally by the single men, the employés and guards, and the colored refugees. The camp was laid out and its military discipline established under the temporary personal command of Surgeon-General Hamilton. So far as known this is the first camp of the kind ever established, at least in the United States. The cottages were arranged in a quadrangle around a parade-ground two acres in extent, and the tents were arranged in streets and alleys in the rear of the cottages. The accommodations were sufficient for 600 people, and extra tents were on hand so that if required 1000 persons could have been provided for, or 3000 per month, allowing for only ten days' detention of each person. Two hundred hospital-tents will accommodate 1200 people comfortably, according to Surgeon Hutton, who states that the small A-tents are unsuited for women and children, but will answer for men or boys. Wire-mattress cots should be provided. The marine-hospital officer at Savannah, Ga., was the purchasing agent for the camp, and promptly forwarded all subsistence supplies on requisition by mail or telegraph.

Discipline of the Camp.—On arrival of a train, each passenger was personally examined by a physician, his health-certificate scrutinized, and he was made to await the examination of others. Hand-bags, clothing, and loose wearing-apparel were left in the baggage-car for disinfection. The refugees were then marched to the quartermaster's room for registration and

assignment to quarters. On first arrival they were placed in the southern part of the camp, and in two days, there being no sickness, were moved forward several cabins, and this progression was repeated until the time for discharge.

Twelve guards were employed, under the command of a captain, and were divided into squads of four each. The schedule was so arranged that each guard was on duty two hours and off duty four.

A bugler announced the several calls as follows:—

5.30 A.M., ...	Reveille.
6.00 A.M., ...	Breakfast, employés.
7.00 A.M., ...	Breakfast, guests.
9.00 A.M., ...	Surgeon's call and inspection.
12.00 M., ...	Dinner, employés.
1.20 P.M., ...	Dinner, guests.
4.30 P.M., ...	Surgeon's call and inspection.
5.30 P.M., ...	Supper, guests.
6.00 P.M., ...	Supper, employés.
6.30 P.M., ...	Retreat and change of guard.
9.00 P.M., ...	Retiring taps.

The yellow-fever hospital-camp, under the special charge of Dr. Faget, was located one-half mile from the probation camp. It consisted of 2 frame buildings, 2 hospital and 12 smaller tents, arranged in a double-crescent shape, the avenue in the middle presenting an attractive appearance.

Of the 12 small tents, 4 were for nurses, 3 for employés, 2 for convalescents, and 1 each for drug-store, storage- and dead- house. One of the hospital-tents was used as a dining-room for employés, convalescents, and parents of the sick.

The hospital was established September 3, 1888, and between that date and November 24th 35 cases of yellow fever were admitted and treated, 3 died, and 32 were discharged. Twelve hundred and eleven refugees were received into Camp Perry, nearly all of whom were from the infected district of Jacksonville.

Thirty-five cases of yellow fever were caught by the ten

days' detention, but no case of fever was contracted at the camp, and of the 1208 refugees who passed the required detention and proceeded to different parts of the country, so far as known, not one subsequently developed or carried the disease elsewhere. The general plan of the preventive measures adopted during this epidemic will be described under Railroad Quarantine.

Railroad Quarantine, Inspection Service, and Disinfection Stations.—Railroad quarantine, disinfection stations, and inspection service may be described by a brief account of the actual measures of this nature, made use of during the yellow-fever epidemic in Florida in 1888, of which Camp Perry, just described, was an important adjunct. (For details, see annual reports marine-hospital service, 1888 and 1889.)

The Governor of Florida made application to the national authorities, July 16th, for aid, and it was determined to prevent further spread of the disease by disinfecting all baggage from infected localities before permitting its transportation into other States, and by enforcing upon all persons from infected localities seeking to leave the State a probationary detention of ten days.

Accordingly, disinfection-stations were established at two points, through which all persons leaving Florida by rail were obliged to pass. One of these was at Live Oak, in Northwestern Florida; the other at Way Cross, Georgia, near the boundary-line of Northeastern Florida. The only other means of egress from the State was from the sea-ports; but healthy sea-ports maintained a vigorous quarantine against people from the infected districts, and infected sea-ports were not visited by the steam-ship lines, because their vessels would thereby be made liable to quarantine detention at other ports. The fumigation of baggage at Live Oak and Way Cross was accomplished by means of box-cars specially prepared, and subsequently in warehouses, the agent being sulphur dioxide.

Regarding persons, the inspectors, properly uniformed and wearing official shields, boarded the trains when the latter arrived at the inspection-stations, and demanded of each passenger a

certificate, showing where he had been during the previous ten days, which certificate was considered valid only when it bore the seal or signature of some officer of health, or recognized municipal authority. The inspectors themselves were kept informed regarding all infected or suspected localities, and a person coming from such locality was either made to return to it, or given the option of going to the camp of probation, there to spend the ten days' period of probation before being allowed to enter other States.

This was Camp Perry, previously described, located 38 miles south of the Way Cross Station, and 40 miles north of Jacksonville, where the epidemic prevailed chiefly. All egress from Jacksonville was, perforce, through Camp Perry and its ten days' probation.

This camp was a means of protecting not only other States, but the uninfected portions of Florida itself, more particularly Southern Florida, whose health authorities refused to admit within their limits the refugees from the infected districts unless they had passed the period of probation at Camp Perry. To assist in this protection to Southern Florida, no person was allowed to board a south-bound train between Way Cross, on the north, and Orange Park, a station 20 miles south of Jacksonville.

Moreover, through south-bound trains were boarded at Way Cross, and all passengers compelled to furnish evidence of coming from healthful localities. The evidence consisted of certificates from local authorities, baggage-checks, or railroad-tickets showing they were purchased in the North, and in some instances letters showing by the superscription and stamps where the person had been.

No train, excepting the special government train, was allowed to stop at Camp Perry. A government train also carried those who had passed the period of probation from Camp Perry to a point 3½ miles distant, Folkstone, where they were transferred to a regular train running as far north as Way Cross,

Ga., where another transfer had to be made to a regular northbound train. No Florida passenger-car was allowed to go north, and more than 1000 baggage and freight cars were disinfected by government officers before being allowed to leave the State.

The methods of railroad quarantine may also be studied in a review of the action taken to prevent the introduction of small-pox into the United States from Canada, where it prevailed extensively in the fall and winter of 1885, and January and February, 1886.

The following regulations were issued by the Surgeon-General of the Marine-Hospital Service, October, 10, 1885:—

The act approved April 29, 1878, entitled, "An act to prevent the introduction of contagious or infectious diseases into the United States," provides that no vessel or vehicle coming from any foreign port or country where any contagious or infectious disease exists, or any vessel or vehicle conveying persons, merchandise, or animals affected with any contagious disease, shall enter any port of the United States, or pass the boundary-line between the United States and any foreign country, except in such manner as may be prescribed under said act.

Attention is now directed to the prevalence of the contagious and infectious disease of small-pox in Montreal and other places in the Dominion of Canada, and the law referred to is held to apply alike to trains of cars and other vehicles crossing the border, and to vessels entering ports on the northern frontier.

Because, therefore, of the danger which attaches to the transportation of persons and baggage, and articles of merchandise, or animals, from the infected districts, the following regulations are framed, under the direction of the Secretary of the Treasury, and subject to the approval of the President, for the protection of the health of the people of the United States against the danger referred to:—

1. Until further orders all vessels arriving from ports in Canada, and trains of cars and other vehicles crossing the border-line, must be examined by a medical inspector of the Marine-Hospital Service before they will be allowed to enter the United States, unless provision shall have been made by State or municipal quarantine laws and regulations for such examination.

2. All persons arriving from Canada, by rail or otherwise, must be examined by such medical inspector before they will be allowed to enter the United States, unless provision has been made for such examination.

3. All persons coming from infected districts, not giving satisfactory evidence of protection against small-pox, will be prohibited from proceeding into the United States until after such period as the medical inspector, the local quarantine, or other sanitary officer duly authorized, may direct.

4. The inspectors will vaccinate all unprotected persons who desire, or are willing to submit to, vaccination free of charge. Any such person refusing to be vaccinated shall be prevented from entering the United States.

5. All baggage, clothing, and other effects, and articles of merchandise, coming from infected districts, and liable to carry infection, or suspected of being infected, will be subjected to thorough disinfection.

6. All persons showing evidence of having had small-pox or varioloid, or who exhibit a well-defined mark of recent vaccination, may be considered protected, but the wearing-apparel and baggage of such protected persons who may come from infected districts, or have been exposed to infection, will be subjected to thorough disinfection as above provided.

7. Customs officers and United States medical inspectors will consult and act in conjunction with authorized State and local health authorities so far as may be practicable, and unnecessary detention of trains or other vehicles, persons, animals, baggage, or merchandise, will be avoided so far as may be consistent with the prevention of the introduction of diseases dangerous to the public health into the United States.

8. Inspectors will make full weekly reports of services performed under this regulation.

9. As provided in Section 5 of said act, all quarantine officers or agents acting under any State or municipal system, upon the application of the respective State or municipal authorities, are empowered to enforce the provisions of these regulations, and are hereby authorized to prevent the entrance into the United States of any vessel or vehicle, person, merchandise, or animals prohibited under the act aforesaid.

10. In the enforcement of these regulations there shall be no interference with any quarantine laws or regulations existing under or to be provided for by any State or municipal authority.

The following are the special instructions for the guidance of sanitary inspectors, issued by Surgeon H. W. Austin, in charge of the inspection service on the Canadian frontier from Buffalo, N. Y., to the Atlantic coast during the epidemic above referred to (See Marine-Hospital Report, 1886):—

Regulations for Sanitary Inspectors.

The following instructions will be observed by the sanitary inspector on the following-mentioned railroads crossing the United States boundary-line, viz., the Grand Trunk Railway, at Rouse's Point, N. Y., and Island Pond, Vt.; the Passumpsic Railroad, at Newport, Vt.; the Central Vermont Railroad, at Highgate Springs or Saint Albans; the Canada Atlantic, at Rouse's Point, N. Y.; and the Southeastern Railway, at Richford, Vt.:—

All persons bound for the United States coming from Montreal, or other places in Canada where small-pox prevails, must produce satisfactory evidence to the inspector that they are protected by a recent vaccination, or submit to this operation before they are allowed to cross the boundary-line.

Inspectors will vaccinate all unprotected persons free of charge.

Persons coming from Montreal, or suburban villages, will be carefully questioned as to their residence, whether small-pox has occurred in their families, or whether they have been in contact with the disease.

Inquiries should also be made relative to their baggage, whether it consists of bedding, household goods, etc., likely to be infected; and if any person or article of baggage is considered by the inspector infected or likely to introduce the disease into the country, he or it should not be permitted to cross the line into the United States.

You may consider persons protected who may show evidence of having had the small-pox or varioloid, or who exhibit a well-defined mark of vaccination. Accept as evidence of protection a certificate from any physician in good standing that the person presenting the same has been successfully vaccinated. Should you doubt the validity or authenticity of the certificate, you may refuse any such person presenting the same the privilege of crossing the border unless he submits to vaccination. Baggage known to have come from any infected district, and believed to be infected, will be thoroughly fumigated with sulphur at Rouse's Point, Saint Albans, Richford, Newport, and Island Pond.

Weekly reports should be made to Surgeon H. W. Austin, United States Marine-Hospital Service, Burlington, Vt., of the number of trains inspected, number of persons examined, number of persons vaccinated, number of pieces of baggage fumigated, and any other information relative to services performed by the inspector.

It will be observed that all the railroads, five in number, over which passengers or freight might be brought direct from Canada into the New England States were guarded.

Besides the line commanded by Surgeon Austin (Atlantic coast to Buffalo), another line was under the direction of Passed-Assistant-Surgeon Wheeler, at points east of Buffalo, and still another on the Michigan frontier, under command of Surgeon W. H. Long. These lines were established at the request and with the co-operation of the authorities of the respective States. Thirty-six inspectors were employed at 37 stations, who examined 49,631 persons on railroad-trains, vaccinated 16,547, and detained or sent back 603. The contents of more than 7000 pieces of baggage were disinfected. The measures taken were successful.

The following are the rules for railroad quarantine adopted by the Quarantine Conference held in Montgomery, Ala., March 5th to 7th, 1889:—

1. Quarantine should not be made against any place until it is officially known that yellow fever or other infectious or contagious disease exists at such place.

2. Only competent physicians should be put in charge of quarantine stations, and only thoroughly-qualified persons should be employed as inspectors on railway-trains.

3. Quarantine stations located on railroads should be established at convenient points, on one or both sides of a town or station, as may be deemed necessary.

4. If an epidemic of yellow fever or other infectious or contagious disease exist at a town or station, trains carrying passengers or freights should be required to pass through the limits of such towns or stations at a speed of not less than ten miles per hour, without stopping at such towns or stations, but should stop at the quarantine station.

5. Passengers to or from such infected point should only be received or delivered at the quarantine station, under the supervision of the quarantine officer in charge of the station.

6. Railway-tickets may be sold to persons leaving an infected place to any point willing to receive them.

7. All baggage from any infected point should be properly disinfected.

8. As far as practicable, the same rules proposed for railroads should be applied to vessels of every kind, stage-coaches, or other means of travel.

9 The passage of railroad-trains through any point on the line of road, whether infected or not, should not be prohibited by any quarantine regulations. The conductors of passenger-trains should close the windows and ventilators and lock the doors of cars passing through any place where a train is not permitted to stop.

10. All freight to any infected place should be delivered either at the quarantine station or the nearest railway-station to such infected point where it can be properly cared for.

11. All mail-matter from any infected place should be properly disinfected by the United States Government; and mail-matter intended for infected points should be put off the trains at the quarantine stations. The United States Government should instruct postmasters to receive and deliver mails at such quarantine stations.

12. Railroads and express companies may receive for transportation from any infected place, during the time such infection exists, any merchandise or traffic consigned to places willing to receive it.

13. State authorities should employ competent persons on passenger-trains as inspectors of passengers, baggage, and express matter, as additional precaution; but the fact of inspectors being on such trains should not relieve trains carrying passengers or express matter or baggage from stopping at quarantine stations for such inspection as the officer in charge may determine to be necessary.

14. It is recommended that all quarantines, as far as practicable, should be uniform in their requirements and operations, which will greatly contribute to the prevention of panics, and tend to allay unnecessary excitement and fear on the part of the people.

15. The form of health certificate adopted by the Quarantine Convention, held at Montgomery, March 5, 1889, should be prepared for health officers to issue to such persons as may be found entitled to receive the same. A copy of this certificate should be printed with these rules, and conspicuously posted at railway-stations.

16. It is the desire and intention of health authorities, as far as practicable, to throw every safeguard around the public health of all localities. Municipal, county, and State authorities are expected to co-operate in every possible way with health officers located in towns, villages, and cities, and in charge of quarantine stations, to enable them to prevent the introduction or spread of yellow fever or other infectious or contagious diseases.

It was also resolved by this conference that the best form of disinfectant for personal baggage is moist heat.

CORRELATION OF MUNICIPAL, STATE, AND NATIONAL QUARANTINE LAWS.

As shown in the foregoing pages, quarantines are administered under three forms of government,—local, State, and national. A vessel arriving at a given port may be refused permission to discharge cargo by authority of either a national statute, a State law, or a city ordinance. At Brooklyn, for example, if the United States officers should consent to a vessel's entry and discharge, restraint could still be imposed by the State officers; and if the latter also should consent, the city authorities could still prevent. In some instances, as at Philadelphia and New Orleans, municipal officers are included in the State quarantine boards, and harmony of action between city and State is thus assured. But, unfortunately, there are still a few States which exercise either little or no supervision of quarantines, so that a county or village quarantine may be purely a local affair conducted without regard to neighboring counties or villages or to the rest of the State. It is this form of quarantine which, in times of epidemic and panic, has for so many years wrought untold misery, which has given rise to the shot-gun quarantines, checked all the currents of trade and social intercourse, arrayed county against county, village against village, and turned the hand of neighbor against neighbor in a ferocious struggle to ward off the pestilence.

Instances of this form of quarantine were numerous in the Southern States during the yellow-fever epidemic of 1878, when the policy of non-intercourse between communities was so rigidly enforced that many were cut off from subsistence supplies, and there was danger of starvation.

Much has been written upon the folly of the shot-gun quarantines, yet communities employing this method have, under their peculiar circumstances, acted wisely, and the results, as compared with those of similar communities neglecting this method, have demonstrated its merit. The blame for all the hardships and suffering entailed is to be laid upon those whose

business it is to make the laws of the State. In the States indicated there were no State boards of health, or they were clothed with but little authority, or, being formed in conjunction with the board of some principal sea-board city, gave little attention to inland districts.

The most recent illustration of the difficulties made by local quarantines, without State supervision, was in Florida during the yellow-fever epidemic of 1888, when the whole State, there being no central sanitary authority, was in confusion through the enactments of village, county, and city boards of health, all acting independently, with no common plan or guidance. When finally, by request of the Governor, the United States authorities assumed control, the petty enactments of these small local boards, and their adherence to their rights, gave great trouble to the government officers, some of whom experienced great delay and personal hardships in getting through the local lines to the points of danger and activity to which they had been ordered. This epidemic demonstrated clearly the need of a State board of health, which the Legislature has since established. State boards of health do not do away with local boards, but make them work in harmony on broad plans laid down in the interest of all.

But there are States which yet have no boards of health, where, in case of epidemic, the old confusion might arise were it not for a new exercise of power on the part of the national government, made possible by the Act of Congress, approved March 28, 1890, known as the Interstate Quarantine Act, to which further reference will be made.

Having shown the necessity of State supervision over village and county quarantines, it is now pertinent to consider the relation of the States to one another. Theoretically, in maritime quarantine, there is opportunity for clashing. One State might be very rigid in its exactions, while a neighboring State, owing to financial stringency, indifference, or a desire to divert the commerce of the first to its own ports, might be very

lax. On this account, and to secure uniformity of procedure, it has been urged that all maritime quarantines should be given over to the national government. It is not intended to enter into this subject exhaustively, but it may be remarked that practically there is little clashing between the State maritime quarantines; and that, while the national government could readily and effectively conduct all the more important quarantines upon the coast, to establish or maintain the very numerous smaller ones would be an excess of responsibility and labor. Moreover, it would seem that the people of each section are best qualified to judge of measures of protection required by their own peculiar surroundings; and if they were not it might still be a questionable public policy to relieve the State governments of this sanitary responsibility, and encourage thus a weak leaning upon the national government. But another view of the matter is had from the stand-point of the interior States. The interior States are as much interested in the efficiency of quarantine at New York or New Orleans as are the cities named, for fomites failing of proper disinfection at these points are rapidly carried to innumerable localities in the interior. Thus, in a measure, the people of the whole interior are dependent upon these quarantines, that is to say, upon the legislative liberality of the States in question, and the efficiency of their executive officers.

Should, however, there be a persistently lax maritime quarantine on the part of a State, the interior States could maintain inland quarantine against the offending one, and by thus restricting its commerce compel a greater efficiency. Should an epidemic disease obtain lodgment in a State the others may, and frequently do, quarantine against it. In the Southern States particularly the interruption to interstate commerce has been frequent by reason of quarantines. The effect of this has been beneficial in that it has stimulated the health authorities in their efforts to exclude epidemic disease. But if there is danger of the spread of cholera, yellow fever, small-

pox, or plague from one State to another, the national authorities, by virtue of the interstate quarantine act, may adopt the necessary preventive measures.

The relation which the national government has always borne toward the States in the matter of quarantine is that of a powerful ally, in the absence of local quarantine assuming jurisdiction, giving aid, when requested, to weak quarantines, and establishing quarantines at points, as the Delaware Breakwater and Cape Charles, where one establishment serves for the protection of several States. All national quarantines have been located by the request or ready assent of the States in proximity.

While it has been urged that quarantine is a function of the general government by reason of the constitutional right of Congress to regulate commerce, the other theory has prevailed, viz., that it is a police power appertaining to the State. The first quarantine laws were enacted by the States or colonies, by Massachusetts, for example, as early as 1648.

A resolution looking to the national control of quarantine was offered in the Fourth Congress, April 28, 1796, as follows: "*Resolved*, That the President of the United States be authorized to direct such quarantines to be performed on all vessels from foreign countries arriving at the ports of the United States as he shall judge necessary." This resolution failed to pass, but one was adopted authorizing the President "to direct the revenue officers and the officers commanding ports and revenue-cutters to *aid* in the execution of quarantine laws, and also in the execution of the health laws of the States respectively, in such manner as may to him appear necessary." From that time until the passage of the interstate quarantine act of 1890, there was no national quarantine legislation that was not distinctively and only in aid of State laws.

With regard to quarantine fees, however, without which many State and local quarantines could not be maintained, it is noticeable that Congress, while not forbidding their exaction, declares, in Section 4792 of the Revised Statutes, that "nothing in

this Title shall enable any State to collect a duty of tonnage or impost without the consent of Congress." The inference is that Congress, in its constitutional power to regulate commerce, is unwilling to formally surrender this right.

The right of the State to impose fees has been affirmed, however, by the Supreme Court of the United States.

Before extending quarantine aid to a State it is the custom of the government to obtain a formal request from the Governor or State sanitary authorities. The agent of the government is the Surgeon-General of the Marine-Hospital Service, who assumes then the direction of expenditures and measures. When necessary the employés, sanitary guards, etc., of the Marine-Hospital Service are given a proper legal footing by being sworn in as State or local officers, deputy sheriffs, etc., and likewise under the law State officers may be endowed with the authority of United States sanitary officers. In this manner the national and State authorities work together harmoniously. Following are the United States quarantine laws in full:—

UNITED STATES QUARANTINE LAWS AND REGULATIONS.

Section 4792, Revised Statutes of the United States.

The quarantines and other restraints established by the health laws of any State, respecting any vessels arriving in, or bound to, any port or district thereof, shall be duly observed by the officers of the customs revenue of the United States, by the masters and crews of the several revenue-cutters, and by the military officers commanding in any fort or station upon the sea-coast; and all such officers of the United States shall faithfully aid in the execution of such quarantines and health laws, according to their respective powers and within their respective precincts, and as they shall be directed, from time to time, by the Secretary of the Treasury. But nothing in this Title shall enable any State to collect a duty of tonnage or impost without the consent of Congress.

NATIONAL QUARANTINE ACT.

AN ACT to prevent the introduction of contagious or infectious diseases into the United States.

Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled, That no vessel or vehicle coming from any foreign port or country where any contagious

or infectious disease may exist, and no vessel or vehicle conveying any person or persons, merchandise, or animals infected with any infectious or contagious disease, shall enter any port of the United States, or pass the boundary-line between the United States and any foreign country, contrary to the quarantine laws of any one of said United States, into or through the jurisdiction of which said vessel or vehicle may pass, or to which it is destined, or except in the manner and subject to the regulations to be prescribed, as hereinafter provided.

SEC. 2. That whenever any infectious or contagious disease shall appear in any foreign port or country, and whenever any vessel shall leave any infected foreign port, or, having on board goods or passengers coming from any place or district infected with cholera or yellow fever, shall leave any foreign port, bound for any port in the United States, the consular officer, or other representative of the United States at or nearest such foreign port shall immediately give information thereof to the Supervising Surgeon-General of the Marine-Hospital Service, and shall report to him the name, the date of departure, and the port of destination of such vessel; and shall also make the same report to the health officer of the port of destination in the United States, and the consular officers of the United States shall make weekly reports to him of the sanitary condition of the ports at which they are respectively stationed; and the said Surgeon-General of the Marine-Hospital Service shall, under the direction of the Secretary of the Treasury, be charged with the execution of the provisions of this act, and shall frame all needful rules and regulations for that purpose, which rules and regulations shall be subject to the approval of the President, but such rules and regulations shall not conflict with or impair any sanitary or quarantine laws or regulations of any State or municipal authorities now existing, or which may hereafter be enacted.

SEC. 3. That it shall be the duty of the medical officers of the Marine-Hospital Service and of customs officers to aid in the enforcement of the national quarantine rules and regulations established under the preceding section; but no additional compensation shall be allowed said officers by reason of such services as they may be required to perform under this act, except actual and necessary traveling expenses.

SEC. 4. That the Surgeon-General of the Marine-Hospital Service shall, upon receipt of information of the departure of any vessel, goods, or passengers from infected places to any port in the United States, immediately notify the proper State or municipal and United States officer or officers at the threatened port of destination of the vessel, and shall prepare and transmit to the medical officers of the Marine-Hospital Service, to collectors of customs, and to the State and municipal health

authorities of the United States weekly abstracts of the consular sanitary reports and other pertinent information received by him.

SEC. 5. That whenever, at any port of the United States, any State or municipal quarantine system may now or may hereafter exist, the officers or agents of such system shall, upon the application of the respective State or municipal authorities, be authorized and empowered to act as officers or agents of the national quarantine system, and shall be clothed with all the powers of United States officers for quarantine purposes, but shall receive no pay or emolument from the United States. At all other ports where, in the opinion of the Secretary of the Treasury, it shall be deemed necessary to establish quarantine, the medical officers or other agents of the Marine-Hospital Service shall perform such duties in the enforcement of the quarantine rules and regulations as may be assigned them by the Surgeon-General of that Service under this act: *Provided*, That there shall be no interference in any manner with any quarantine laws or regulations as they now exist, or may hereafter be adopted under State laws.

SEC. 6. That all acts or parts of acts inconsistent with this act be, and the same are hereby, repealed.

Approved April 29, 1878.

[Extract from Quarantine Act of August 1, 1888.]

AN ACT to perfect the quarantine service of the United States.

Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled, That whenever any person shall trespass upon the grounds belonging to any quarantine reservation, or whenever any person, master, pilot, or owner of a vessel entering any port of the United States, shall so enter in violation of Section 1 of the act entitled, "An act to prevent the introduction of contagious or infectious diseases into the United States," approved April twenty-ninth, eighteen hundred and seventy-eight, or in violation of the quarantine regulations framed under said act, such person, trespassing, or such master, pilot, or other person in command of a vessel shall, upon conviction thereof, pay a fine of not more than three hundred dollars, or be sentenced to imprisonment for a period of not more than thirty days, or shall be punished by both fine and imprisonment, at the discretion of the court. And it shall be the duty of the United States attorney in the district where the misdemeanor shall have been committed to take immediate cognizance of the offense, upon report made to him by any medical officer of the Marine-Hospital Service, or by any officer of the Customs Service, or by any State officer acting under authority of Section 5 of said act.

SEC. 2. That as soon after the passage of this act as practicable, the Secretary of the Treasury shall cause to be established, in addition to the quarantine established by the act approved March fifth, eighteen hundred and eighty-eight, quarantine stations, as follows: One at the mouth of the Delaware Bay; one near Cape Charles, at the entrance of the Chesapeake Bay; one on the Georgia coast; one at or near Key West; one in San Diego Harbor; one in San Francisco Harbor; and one at or near Port Townsend, at the entrance to Puget Sound; and the said quarantine stations when so established shall be conducted by the Marine-Hospital Service under regulations framed in accordance with the act of April twenty-ninth, eighteen hundred and seventy-eight.

* * * * * * * * * * * *

Approved August 1, 1888.

AN ACT to prevent the introduction of contagious diseases from one State to another and for the punishment of certain offenses.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That whenever it shall be made to appear to the satisfaction of the President that cholera, yellow fever, small-pox, or plague exists in any State or Territory, or in the District of Columbia, and that there is danger of the spread of such disease into other States, Territories, or the District of Columbia, he is hereby authorized to cause the Secretary of the Treasury to promulgate such rules and regulations as in his judgment may be necessary to prevent the spread of such disease from one State or Territory into another, or from any State or Territory into the District of Columbia, or from the District of Columbia into any State or Territory, and to employ such inspectors and other persons as may be necessary to execute such regulations to prevent the spread of such disease. The said rules and regulations shall be prepared by the Supervising Surgeon-General of the Marine-Hospital Service, under the direction of the Secretary of the Treasury. And any person who shall willfully violate any rule or regulation so made and promulgated shall be deemed guilty of a misdemeanor, and upon conviction shall be punished by a fine of not more than five hundred dollars, or imprisonment for not more than two years, or both, in the discretion of the court.

SEC. 2. That any officer, or person acting as an officer, or agent of the United States at any quarantine station, or other person employed to aid in preventing the spread of such disease, who shall willfully violate any of the quarantine laws of the United States, or any of the rules and regulations made and promulgated by the Secretary of the Treasury as provided for in Section 1 of this act, or any lawful order of his superior

officer or officers, shall be deemed guilty of a misdemeanor, and upon conviction shall be punished by a fine of not more than three hundred dollars, or imprisonment for not more than one year, or both, in the discretion of the court.

SEC. 3. That when any common carrier or officer, agent, or employé of any common carrier shall willfully violate any of the quarantine laws of the United States, or the rules and regulations made and promulgated as provided for in Section 1 of this act, such common carrier, officer, agent, or employé shall be deemed guilty of a misdemeanor, and shall, upon conviction, be punished by a fine of not more than five hundred dollars, or imprisonment for not more than two years, or both, in the discretion of the court.

Approved March 28, 1890.

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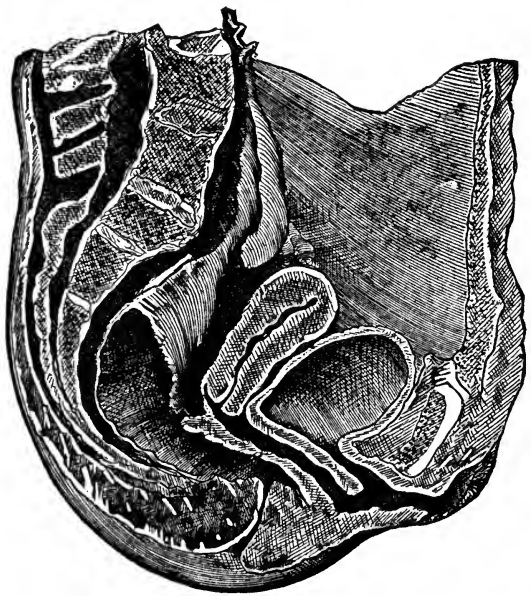

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ACONITE LEAVES, ... 4 A.

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(a) Aconitine.	Narcotic and Apyretic.	1-500 gr.	1-16 gr.

Following this, Preparations of the Pharmacopœia, each tabulated. For example:

TINCTURAL.

TINCTURA.	DRUG.	AMOUNT.	ALCOHOL.	DOSE.
* Aconiti.	{ Aconite. { Tartaric Acid, 60 † P.	5½ oz. to 24 gr.	100	1 to 3 drops.

* 60 Fineness of Powder as per U. S. P.
† P. Macerate 24 hours. Percolate, adding Menstruum to complete (1) pint tincture.

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NAME.	DOSES.	SPECIFIC GRAVITY.	SALT OR ALKALOID.	MEMORANDA.

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FIG. 15.—AUTHOR'S FIBROID SPEAR.

FIG. 18.—BALL ELECTRODE FOR ADMINISTERING FRANKLINIC SPARKS.

CONTENTS

CHAPTER I, Introductory; II, Apparatus required in gynecological applications of the galvanic current; III, Experiments illustrating the physical qualities of galvanic currents; IV, Action of concentrated galvanic currents on organized tissues; V, Intra-uterine galvano-chemical cauterization; VI, Operative details of pelvic electro-puncture; VII, The faradic current in gynecology; VIII, The franklinic current in gynecology; IX, Non-caustic vaginal, urethral, and rectal applications; X, General percutaneous applications in the treatment of nervous women; XI, The electrical treatment of fibroid tumors of the uterus; XII, The electrical treatment of uterine hemorrhage; XIII, The electrical treatment of subinvolution; XIV, The electrical treatment of chronic endometritis and chronic metritis; XV, The electrical treatment of chronic diseases of the uterus and appendages; XVI, Electrical treatment of pelvic pain; XVII, The electrical treatment of uterine displacements; XVIII, The electrical treatment of extra-uterine pregnancy; XIX, The electrical treatment of certain miscellaneous conditions; XX, The contra-indications and limitations to the use of strong currents.

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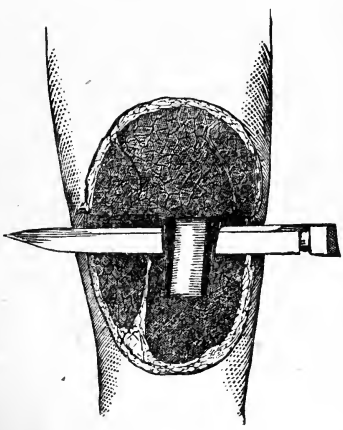

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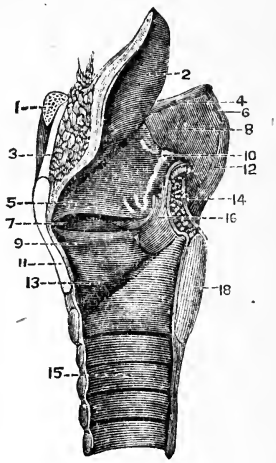

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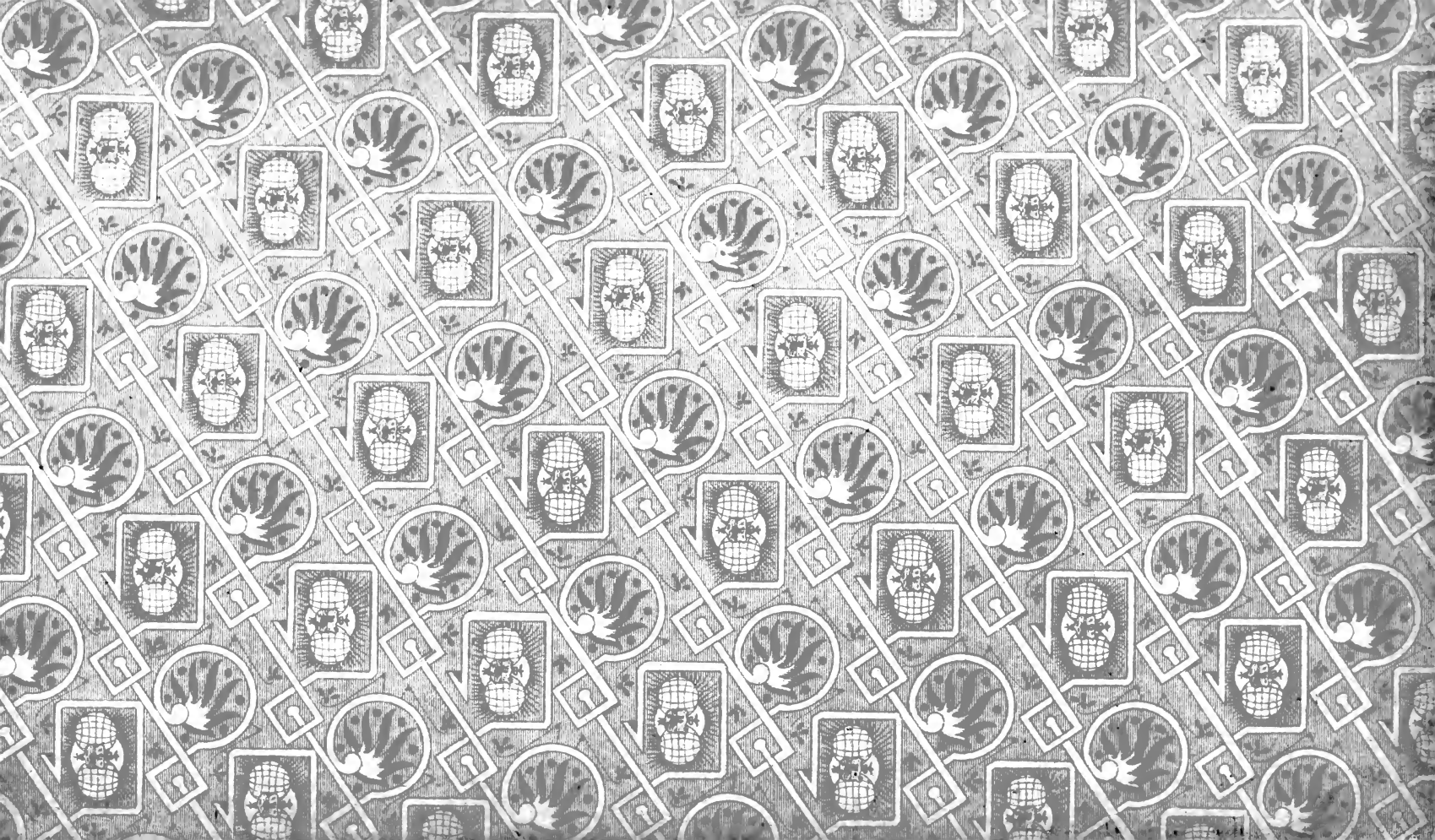

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